

Computer Utilization by Construction Contractors in Saudi Arabia

by

Muhammad Hasan Al-Amir

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES
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DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

January, 1994

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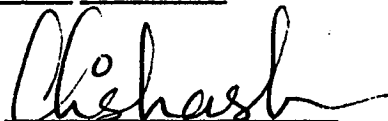
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**KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DHAHRAN 31261, SAUDI ARABIA**

COLLEGE OF GRADUATE STUDIES


This thesis, written by **MUHAMMAD HASAN AL-AMIR**, under the direction of his Thesis Advisor and approved by his Thesis Committee, has been presented to and accepted by the Dean of the College of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE**.

Thesis Committee



Thesis Advisor

Dr. Ali A. Shash



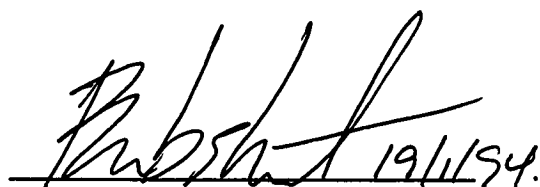
Member

Dr. Sadi A. Assaf



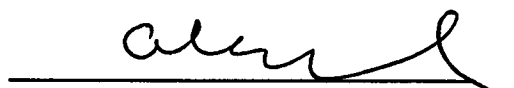
Member

Dr. Abdullah Al-Sukairi



Department Chairman

Dr. Abdul-Aziz Bu-Bshait


Dean, College of Graduate Studies
Dr. Ala H. Rabeh

19.1.94
Date



الاهداء

الى والدي الكريمين ...

اللذين لم أجد من هو أحق منهما بالاهداء .

اليهما أهدي هذا العمل ...

ثمرة من ثمار تربيتهما و غرسهما ،

داعيا الله أن يحفظهما .

((وقل رب ارحمهما كما ربياني صغيرا))

DEDICATED TO MY BELOVED PARENTS

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THESIS ABSTRACT

FULL NAME OF STUDENT: MUHAMMAD HASAN AL-AMIR

**TITLE OF STUDY: COMPUTER UTILIZATION BY CONSTRUCTION
CONTRACTORS IN SAUDI ARABIA**

MAJOR FIELD: Construction Engineering and Management

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The accelerating pace of the information technology and the growing size and power of both computer systems and software make the use of computers in many industries essential. This study investigates the use of computers by large, medium, and small sized contractors in Saudi Arabia. The main objectives of this study is to investigate the type and the extent of computer use among contractors, to reveal the areas and functions of contractors that are computerized, and to investigate the factors that are responsible for the observed extent of use.

A questionnaire was developed and mailed to 300 construction contractors all over Saudi Arabia. These contractors were selected randomly from a list of classified contractors. Ninety three contractors participated in the study.

The results show that only 55 percent of all contractors are using computers, mainly microcomputers, in their firms. However, it was found that as the size of the firms get bigger, the percent of users increases. All large sized contractors, sixty two percent of medium sized contractors, and only 41 percent of small sized contractors are using computers in their business operations.

The results show that accounting process is widely computerized among those who use computers. The creation of databases is the second function that computers are used for in construction firms. Contractors use computers widely for word processing.

The results indicate that lack of computer experience and difficulty in selecting the appropriate computer systems are heavily ranked as factors hindering the use of computer technology by construction contractors, especially small and medium sized contractors.

**MASTER OF SCIENCE DEGREE
KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
Dhahran, Saudi Arabia
January 1994**

خلاصة الرسالة

اسم الطالب الكامل : محمد حسن الامير
عنوان الدراسة: استخدام الحاسب الالى في مؤسسات التشييد في المملكة العربية السعودية
التخصص : هندسة و ادارة التشييد
تاريخ الشهادة : يناير ١٩٩٤ م

ان التقدم في تقنية المعلومات ونمو قوة وقدرة أنظمة الحاسبات الالية وبرامجها حتم استخدامها في كثير من المجالات. تبحث هذه الدراسة استخدامات الحاسب الالى من قبل مؤسسات التشييد الصغيرة و المتوسطة و الكبيرة في المملكة العربية السعودية وتهدف الى بحث انواعها ومدى استخدامها في مؤسسات التشييد وفي أي المجالات يتم استخدامها بالإضافة الى دراسة العوامل المؤثرة في مدى الاستخدام الناتج من هذه الدراسة.

لقد تم عمل استبيان لجمع المعلومات المطلوبة واختير عشوائيا ٣٠٠ من مؤسسات التشييد في جميع انحاء المملكة العربية السعودية من قائمة المقاولين المصنفين من قبل وكالة تصنيف المقاولين بوزارة الاشغال العامة والاسكان، وتم ارسال الاستبيان اليهم بريديا وقد رد ٩٣ منهم على الاستبيان.

اظهرت النتائج ان ٥٥ بالمائة من المقاولين يستخدمون الحاسبات الالية خصوصا الحاسبات الشخصية في مؤسساتهم. كما ان نسبة استخدام الحاسب الالى تزداد كلما كبر حجم المؤسسة. فجميع المقاولين الكبار اظهروا استخدامهم للحاسبات الالية بينما يستخدمها ٦٢ بالمائة من المقاولين متوسطي الحجم و ٤١ بالمائة فقط من صغار المقاولين.

واظهرت النتائج ان الاعمال المحاسبية هي اكثر الوظائف التي يستفاد الحاسب الالى في عملياتها بينما كانت قواعد المعلومات ثانيها. كما اظهرت استخداما واسعا للحاسبات الالية في مجال تنسيق النصوص.

ان عدم وجود الخبرة الكافية في مجال الحاسبات الالية بالإضافة الى الصعوبة المتمثلة في اختيار نظمها وبرامجها المناسبة هما العاملين الاعم وراء الاستخدام المتدني للحاسبات الالية في مؤسسات التشييد خصوصا المتوسطة والصغيرة منها كما اتضح من الدراسة.

درجة الماجستير في العلوم

جامعة الملك فهد للبترول و المعادن
الظهران ، المملكة العربية السعودية

يناير ١٩٩٤ م

CHAPTER 1

INTRODUCTION

Information has always been a valuable resource in any type of organization. Management of information should not be separated from the development of technology (Liou 1987). Human beings as data handling machines are particularly good at handling very large quantities of data in a very imprecise way, but poor at repetitive and precise retrievals. The use of computer technology has brought services to vast numbers of people which until recently could only be given to a few (Paterson 1977).

The construction industry is highly dependent on the collection and use of information (Stewart 1986). The success or failure of a construction contract is largely dependent upon the quality and timing of the information available (Paterson 1977). In addition, in order to successfully plan and subsequently control the construction process, a construction firm must collect, process, and interpret vast amounts of information and data. The task of data and information management has often overwhelmed the contractor. The fact that contractors are small, closely held companies has resulted in many firms being unable to cope with adequate and necessary data collection and processing (Stewart 1986).

The construction industry has often been characterized as an industry that lacks record keeping, management techniques, and a scientific approach to problem solving. Moreover, the construction industry has basically not been a highly scientific, mathematically oriented industry. (Stewart 1986)

The entry of computer technology gives a contractor a potential tool for the efficient handling of the vast amount of information that is part of his business (Stewart 1986). More and better information can lead to better decisions; better decision-making leads to more effective control. The computer manipulates and provides information for the decision maker with unprecedented speed and accuracy (ASCE Task Committee 1985).

A steady stream of new products has had a great impact on our lifestyles. Some are already having an impact on the construction profession. Still others have the potential to affect the future well-being and growth of our profession. Among those is the computer. (Thigpen 1981)

Computers with millions of characters of disk storage and dozens of visual display unit screens, are a practical proposition (Cornwall 1985). The availability of computers has opened up the automation of many management tasks in the construction industry (Suckarich 1984). The power of the computer has enabled many users to gain accurate information in a fraction of the time and cost previously involved with project management systems (Baker 1985).

1.1 STATEMENT OF THE PROBLEM

Significantly changing conditions on construction projects in recent years have created a need for revised approaches to project management control. These changes include: (Skibniewski 1990; Vandersten 1979)

- Increased scope, complexity and duration of projects.
- Integration of different construction specialization.
- Decreased productivity.
- Increased costs.
- Excessive litigation.
- Increasing rate of bankruptcy.

Other factors, in addition, necessitate the utilization of computers in construction practice. First, the construction industry finds itself working in a commercial and business climate which has changed dramatically. Construction clients in the retail trade, banking, and finance, manufacturing industries, etc., are increasingly and intensively more and more computer conscious. The speed of business activity in general is demanding a faster and more efficient response from constructors and contractors. Secondly, competition is a very vital issue. Competition, from within the industry, demands greater economy and increased efficiency. (Farrett 1986)

Apart from improved data handling facilities, computer networks open up the possibilities for video conferencing. This eventually reduces the need for

traveling to remote sites or the necessity for keeping large contingents of senior engineers on site. For countries which are concerned by rising numbers of expatriates, or which have manpower shortages, such as Saudi Arabia, the prospects are exciting. In addition, Saudi Arabia is building entire cities where there used to be nothing but desert. This means the construction of utilities, schools, hospitals,... etc. In the Kingdom, the applications of computers to these projects will facilitate and dramatically accelerate construction. (O'Connor 1983, Morris 1983)

There has been a gradual recognition by management of the need for improved information to plan, execute, and control all stages of project activities much more effectively than before. It has been recognized that there is a need to integrate large volumes of data, to analyze more alternatives and develop more effective budgets; and to develop more effective management reporting, procedures, and controls. (Vandersten 1979)

Although it is very difficult to relate contractor profits (or lack of profits) to any one task that includes data collection and data processing, one can state that contractor financial failure can be traced to data collection/processing functions more often than marketing or production causes. Many surveys have been carried out to determine the causes for contractor financial failure. One of these, compiled by Dun and Bradstreet, indicated that the majority of reasons for contractor failure relate to functions that require the collection, processing, and analysis of data/information (Stewart 1986).

The increased information needs, coupled with rapid development in computer technology, both hardware and software, have focused increased attention on the use of computers for construction project management systems (Vandersten 1979). A computer system manages a tremendous amount of information in a format that can help the decision-makers make intelligent, informed business decisions (Murrer 1987). The use of computer techniques has a great deal to offer, bringing with it the facility to analyze and process large volumes of information quickly, accurately, and economically (Parrett 1986).

The operation of computer systems in construction management enables the construction practice to offer its clients a faster and more efficient service (Building 1985). The opportunity to increase profitability, decrease financial risks, improve accuracy, save executive time, and to faster manage information are major benefits sought from computer applications (Building 1987). The payback of introducing computers in a construction firm can be enormous in terms of direct savings, increased productivity, and the far reaching benefits of having entered the computer age (Rounds 1984).

Coincidentally, over the past 30 or 40 years, the evolution of the construction industry has paralleled a comparably rapid growth in the oil revenues that have supported the various national construction investment programs in Saudi Arabia (Morris 1983). Over the last decade, depressed oil prices and the winding down of infrastructure programs have combined to

create what is perceived to be a recession in Saudi Arabia's construction industry (MEC 1987). The shrinkage of budgets has forced once spendthrift clients to look more closely at competitive tendering, resulting in a very competitive construction environment (MEC 1987; Moore 1985). The contractor's profit margin has been on the decline as well as the demand for construction (MEC 1987). This situation might have created pressure on Saudi contractors to be more competitive for the sake of survival and profitability. Competitiveness is the result of the application of proper managerial tools that increase the efficiency of the contractor's management. Information handling is a major function that ensures efficient management. The use of the computer in information handling is becoming a major requirement.

Due to the absence of information regarding computer use in the construction firms in Saudi Arabia, this study is an attempt to reveal the utilization of computers among construction contractors operating in Saudi Arabia. Such a study will determine how much technology is utilized. This study will fill a gap in knowledge of the Saudi construction environment regarding an issue that has been very important for contracting firms worldwide.

1.2 OBJECTIVES

The main objectives of this study are:

1. Investigating the extent of use of computers by construction contractors in Saudi Arabia.
2. Investigating the applications where computers are utilized by construction contractors.
3. Investigating the factors that contribute to the extent of use of computers by construction contractors.

1.3 SCOPE AND LIMITATION

The scope of this study is the applications of computers by construction firms (contractors) in general. The study is limited to the construction industry in Saudi Arabia. The intent of this study is to overview the application of computers not the software or packages utilized specifically.

CHAPTER 2

LITERATURE REVIEW

The utilization of computer technology in the construction industry has been addressed by many researchers. The issue of computer technology utilization in construction has received a lot of attention. In the literature, the increasing interest in such matters in architectural, civil, and computer specialist publications, is increasing the awareness of the role of computers among many professions, including construction. The introduction of computers in construction, the advantages they offer to contractors, the procedures on how to use the technology, procedures assisting contractors in decision making towards computerization, and overall application are shown. Although no studies were found addressing computer utilization in the Saudi construction environment, the same principles can be valid elsewhere. The literature review chapter is divided into two main sections. The first section covers computer technology. The second part will highlight computers in construction and some studies and surveys conducted relating to the issue of computer utilization in construction firms.

2.1 THE MICROCOMPUTER REVOLUTION

Microcomputers are small but relatively powerful computers which have gained rapid acceptance for many applications. "Personal" refers to the primary

application of a business machine for dedicated use by individuals (Rounds 1984). The microcomputer has increasingly involved people directly in computer use as they apply their own computers to solve the problems they face every day (Rounds 1987). The demand for main frames and minicomputers looks relatively unexciting when compared with the growth of micros for first time users (Building 1987).

The development of the microprocessor has played a great part in lowering the cost of computers and, in particular, the cost of microcomputers. The use of microcomputers is expanding as the costs of acquiring such computer systems and software continue to decline. Microcomputers offer advantages and capabilities that are not available in computer systems costing much more. These small, yet powerful, computing devices are not a "step down" in computing, instead they are at the forefront of data processing technology, signaling the direction that future computer applications will take. Their low cost, compact size, great capabilities, and high potential for profitable applications make them an exceptional tool for use by construction firms. Microcomputers have the ability to communicate with larger mainframe computers. Using a standard telephone and telephone lines, it is possible for microcomputers to utilize the immense capacity of time-sharing computers. (Thigpen 1981)

2.2 COMPUTERS IN CONSTRUCTION FIRMS

The accelerating pace of information technology and the growth of computer and software power make the utilization of computers in many industries even more essential. The construction industry, however, lags behind most other industries in computer usage (Building 1987). If the construction industry is to make sufficient use of all its resources, then an active policy for the introduction of information technology must be pursued (Stewart 1987). For the construction industry, this now means the utilization of technology for key operational and commercial users, such as estimators, buyers, site managers, engineers, and surveyors in a way that is feasible (Cornwall 1985).

Although traditionally, the construction industry is slow to accept changes, it now has the opportunity to make an essential change: taking advantage of the computer at the most appropriate stage of its development (Parrett 1986). Technology and popularity have contributed to the trend of lowering the cost of some products such as microcomputers. This trend is gradually reversing and all indications are that the bottom on cost has been reached and movement is seen in the direction of increased sophistication, capabilities, and, hence, increasing cost (Thigpen, 1981).

The market in which engineering services are rendered, can be characterized as being highly competitive with many firms and clients having few if any barriers to entrance, i.e., non-capital intensive, and offering slight differentiation of services in both quantity and quality. This refers to the fact

that most firms offer the same basic engineering services and there is minimal variation in their quality of execution. Twenty years ago, computerized project management was available only to large firms with mainframe computers. Project management software gives the character a better handle on the resources necessary to complete projects on time (Austin 1990).

The microcomputer is truly revolutionizing the construction industry. The impact of highly sophisticated computer power, placed in the hands of the individual, appears to be far-reaching (Rounds 1987). Given the relatively low price of microcomputer hardware and software, the computer has become almost indispensable to the construction firm, often costing less than a small construction tool or piece of equipment (Stewart 1990). The recent entry of microcomputers has given the construction firm a potential tool for the efficient handling of the vast amount of information that is part of its business. Moreover, the increase in effectiveness, that microcomputers have allowed, has given smaller firms the ability to compete for work with larger firms (Gifford, 1987).

The basic nature of the construction industry is characterized by the implementation of projects requiring high investment, with considerable cash outflow, which makes the moderate cost of a microcomputer of little concern to even the smallest contractor (Fereig 1989).

Several decisions need to be made by the contractor before choosing a computer system to run the business. Who will operate and maintain the

system?, how can manual methods be converted?, which parts of the business should be computerized?... etc. (Murrer 1987). Contractors, since they do not have skills resembling those of computer programmers, simply want a system that will improve their information handling capabilities, knowing only enough to make the system work (Skibniewski 1990).

Many reasons can contribute to low usage of computers such as the initial fear of innovation and reluctance to adopt new tools of the trade and the lack of access to conventional sources of information on computer application engineering. A small contractor is affected, even more than a large contractor, by common problems in the construction industry such as increasing complexity of construction projects, decreasing productivity, increasing costs, excessive litigation, and increasing rate of bankruptcy (Skibniewski 1990).

The major areas of concern are: selecting the appropriate hardware and suitable software, the time needed for training, solving implementation problems, transferring files between different machines if needed, developing software, as well as keeping pace with fast developing technology. Large contractors are the basic users of computers, whether they be main, mini, or micro. Small contractors have only recently become aware of the wide capabilities of computers and begun to introduce them into their companies (Fereig 1989).

The lack of good training programs represents one of the greatest barriers to the implementation and effective use of technology according to

them. Most firms are reluctant to attach a price tag to training individual employees because of the number of variables involved, including employees previous experience, salaries, the duration of training and the complexity of the software. They stated that most firms agree that hands-on training is the best method. Computer-based training gives the user more control. Many individuals do not like to have any one looking over their shoulder (Dorris & Setzer 1990).

2.2.1 APPLICATIONS

The computer can make a tremendous contribution to the design of a comprehensive construction management system (Campbell-Ellen 1985). The development of computers is changing the notion of common construction management functions. The availability of microcomputers, for example, at relatively inexpensive prices has opened the way to automation of many management tasks (Sucharich 1984).

Although the early uses of computers in construction firms were in applications concerning the payroll, accounts payable and overall general ledger accounting functions, today they can play an increasing role in the contractor's project management functions such as estimating (Adrian 1982; Parrett 1986). There seems to be a large gap between potential computer use and actual use (Skibniewski 1990). Where computers were used, they tend to concentrate on administrative functions such as payroll and accounts, rather than construction-related applications such as estimating (Stewart 1987).

Computers are under-utilized for a number of applications, including word processing, scheduling, and estimating (Skibniewski 1990). The information needs of the construction firm are not limited only to functions such as accounting. To be profitable, a construction firm must prepare accurate project estimates, schedules, and cost and time control duties where a significant amount of data/information collection, processing, and interpretation is required (Stewart 1990).

An important application is the use of micro-based Computer Aided Design (CAD) by construction management or general contracting firms. The advent of powerful microcomputers, the advances in computer hardware and CAD software, and their low costs have led to greater use. Dynamic utilization of CAD in areas such as marketing, design, estimating, and scheduling can provide the competitive advantage needed to remain profitable in today's marketplace. Large and small companies can afford these powerful systems: valuable tools to aid in the management of construction activities and the control of a project's time and budget (Tavakoli and Klika 1991).

In addition, functions such as accounting and payroll, as they are expense items, do not contribute significantly to the contractor's income (Liewellyn 1984). Estimating, on the other hand, is a function in which a contractor's success is affected by how well he performs it (Liewellyn 1984). Computers do some jobs, like price extensions for an estimate, very well

(Murrer 1987). Yet, computers are not utilized to good effect when it comes to estimating (Stevens 1987).

Applications in different administrative areas, like payroll, accounts payable and receivable, inventory control, general ledger and word-processing are now widespread in construction companies using microcomputers and related software. Activities related to site, such as scheduling, job progress management, purchasing and procurement, cost control, and equipment management can now be performed using microcomputer software on-site (Feric 1989).

In the area of management reporting, the company automation of report production can significantly reduce the lag time between the report cut-off date and the preparation of reports in the management reporting cycle (Orezyk 1991).

A case study on the application of microcomputer technology in a construction firm showed a major improvement. The firm won a competitive award for a large project. The firm's officers creatively used microcomputers and software packages to solve financial and project management challenges. The success of the firm was tied to the success of this project. Had management or financial control deteriorated, the project and company would have ceased to exist. Use of the computer provided the discipline and control needed to sell, manage, and complete the project successfully. The successful and profitable conclusion of this project demonstrates that little companies

must employ automated management systems to be competitive. It is not only the construction giants that effectively use automation. Automation is necessary for the little company that must squeeze out every penny of profit (Carlson & Carlson 1987).

2.2.2 STUDIES AND SURVEYS

Building (1987) conducting a survey in the United States for "Computer Weekly" has revealed that construction lags behind most other industries in computer usage. Less than one in ten plumbers, plasterers or roofers use computers: a ratio that runs throughout building contractors. It is the lowest ratio for any industry covered in the national survey. The highest score for any building industry in the survey was demolition, where 25 percent of companies have computers. Construction is targeted as the computer industry's number one market and micro sales are predicted to grow at a healthy 20 percent. In terms of software, accounting and payroll are the most commonly used packages. Construction appears to favor the specialist dealer as a preferred supplier, although some small businesses will obtain the cheaper PC from high street outlets.

Skibniewski (1990) conducted a survey regarding the utilization of personal computers by a group of selected small contractors in central Indiana, U.S.A. The survey was designed to collect data for analysis of current utilization by small contracting firms and hindrances preventing microcomputers from being used for more comprehensive applications. The

study showed that there seems to be a large gap between potential microcomputer uses and actual use. A majority of small contractor firms in the U.S. lack sophisticated project management methods. Consequently, their adoption of microcomputers has been very slow and most of the computers being used are in accounting type functions. Microcomputers are under-utilized for a number of applications, including word processing, scheduling, and estimating. The more advanced uses of computers such as database management, computer communication with field office, computer-aided drafting and design, process simulation, risk analysis, and expert systems were virtually unexplored by small contractors. Areas that needed to be improved included software incompatibility, difficulty in obtaining concise information for selecting the optimal system, shortcomings in scheduling and estimating software, and training. It was concluded that when these are improved and the overwhelming quantity of technical information is organized and standardized, small contractors might be expected to take better advantage of available microcomputer systems.

A study was conducted by Ferrig, Qaddami, and El-Akkad (1989) to survey computer application in the Kuwaiti construction industry. The contractors are divided into four classes by the government. The first are those able to participate in tendering to 5 million Kuwaiti Dinar (KD), while for the second it is 1 million KD, for the third 0.5 million KD, and finally for the fourth 0.25 million KD. The survey showed that fifty percent of the construction companies in Kuwait are using computers. Among the companies using computers, 89.7 percent started using them after 1980. Only 9.7 percent

of the users are using mainframes, 25 percent are using mini-computers and 64.5 percent are using microcomputers. It is also noted that third-class companies are using only microcomputers. None of the fourth class companies use computers due to their very small size and minor construction work. The survey revealed that 79.3 percent of all users see the importance of computers to their companies' operations. The major use of computers in administrative applications is accounts, where 88.5 percent of the users use them for such purposes, followed by general ledger and word processing. In engineering applications, around 60 percent of the users are using their computers for estimating and developing cost database. The percentage of use in specification writing is 92 percent while for graphics and shop drawings it is 26 percent. Scheduling is the most predominantly used in project planning and control applications (about 77 percent). Generally, applications in the area of administration ranked first while project planning and control applications came second, followed by engineering applications. Applications used the least were in the area of equipment. Finally, developing the required applications by using generic software, such as spreadsheet, database, or word processing, packages, proved to be the most efficient and least expensive approach.

Bu-Bushait (1989) conducted a survey that included construction projects in the South eastern and Mid-Atlantic regions of the United States regarding project planning and control techniques. The study showed that computer assistance and implementation of project management software was utilized in almost all large construction projects. However, the implementation of computer software was not utilized fully. It was noticed that project

managers used the computer for listing of activities or material delivery dates, ignoring the fact that the computer can perform many other functions including network drawing, bar charting, scheduling updating, resource allocation and leveling and CPM calculation. The study concluded that training programs should be geared toward a major concern: the application of the microcomputer and its role in planning and control of projects and the issue of practicality. Computer software should be designed to encompass the major functions that are really needed for the project manager and should be as simple as possible.

A survey carried out by Green (1989) explores construction equipment managers' use of PCs in their heavy equipment operations. It is found that 67 percent of all respondents use PCs somewhere in their operation. More than four out of five of these equipment managers who have PCs reported that they are used for word processing. About two-thirds of them use PCs for book-keeping, 60 percent use them for cost analysis, and 53 percent use them for payrolls. At the other end of the spectrum, only 9 percent of those with personal computers use them for training. Regarding software selection; 49 percent agree that the equipment manager picks out the software for the hardware, 30 percent point to the owner as the software buyer, 28 percent use a computer specialist. Just 5 percent turn to an equipment manufacturer for software selection, and only one respondent reported using the vendor as the software selection buyer. Packaged software is the most common choice to handle PC applications. 78 percent buy packaged software, 44 percent turn to customized software, and 33 percent design their own software. Operation, hardware compatibility, flexibility, and price are the main selection criteria

looked for. Another survey conducted by Kochn and Cook (1988) aimed to investigate various items and functions in the construction industries and whether technology in a particular region of the world is more advanced than that of the United States. A questionnaire was distributed to a selected number of U.S. international and domestic contractors and designers. The U.S. was perceived to be more advanced overall in the area of Computer Aided Design and Drafting. The Japanese were perceived to be more advanced in robotics. International contractors rated Europe, especially Sweden and Japan as being more advanced in construction management.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter presents all the steps that were taken to achieve the objectives set for this study.

3.1 REQUIRED DATA

The objectives of the study necessitated the identification and operation of the following items.

3.1.1 THE COMPUTER

A computer is a system that performs input, output, storage, arithmetic-logic, and control functions, thus providing users with a powerful information tool. Computers are classified generally into three main categories: mainframe computers, minicomputers, and microcomputers.

3.1.1.1 *The Mainframe Computer*

Mainframe computer systems frequently have one or more central processors with large instruction processing capacities and great processing speed, large primary storage and secondary storage capacities, and the ability

to serve many users at once. Mainframe computers are designed to handle the information processing needs of organizations in business, government, and education with many employees and customers or complex computational problems. Small and medium sized mainframe computers can handle the processing chores of smaller organizations or the regional divisions of larger organizations. They can also handle large numbers of users needing access at the same time to the centralized databases and libraries of application programs of time-sharing networks.

3.1.1.2 *The Minicomputer*

Minicomputers are small computers that are larger and more powerful than most microcomputers but are smaller and less powerful than most of the models of mainframe computer systems. Minicomputers have a wide range of processing capabilities and hardware characteristics. Minicomputers can perform all of the functions of mainframe computers but are typically smaller, lower-cost machines. They might have slower processing speeds, smaller memories, and less input/output and data communication capabilities. Minicomputers were designed to handle a limited set of jobs and peripheral devices. Most minicomputers can also function in ordinary operating environments, do not need special air conditioning or electrical wiring, and can be placed in most offices and work areas. In addition, since they are comparatively easy to operate, the smaller models of minicomputers do not need a staff of data processing professionals but can rely on properly trained regular employees. Minicomputers are being used for a large number of

business data processing and scientific applications. They are now being used as end-user computer systems in distributed processing networks. They also serve as powerful individual engineering workstations. In addition, minicomputers are used as small-business computers. They provide more processing power and on-line storage and can support more users at the same time than microcomputers when used for business applications.

3.1.1.3 *The Microcomputer*

The expanding electronic technology field has brought about the development of small size, relatively low cost computer memory and processing units, and other hardware that has enabled the production of desk top computers. These types of desk top computers are called microcomputers (Gifford 1987). A microcomputer can be defined as an electronic computer which has as its primary operations element, a device called a "microprocessor" (Thigpen 1981). "Personal" refers to the primary application of a business machine for dedicated use by individuals. It does not have multiple terminals though it can be networked with other personal computers (Rounds 1984). They are referred to as desk-top because they can easily fit on a desk (Stewart 1986).

The American Society of Civil Engineers (ASCE) Task Committee on Microcomputer Utilization in Construction defined a professional desk top microcomputer system as consisting of Central Processing Unit (CPU) with at least 64-K bytes of Random Access Memory (RAM), and 80-character by 24-

line Cathode Rode Tunnel (CRT), one or more external floppy disk-drive units, and a dot matrix. (Skibniewski 1990)

A distinct advantage of microcomputers are their ability to be a stand alone computer as well as an intelligent terminal in a distributed network system. Microcomputers are also used as part of large computer integrated engineering system. (Gifford 1987)

The stand Alone System is the most common use of the microcomputer. In addition to the computer's processing unit and monitor, this system might also include such hardware as one or more disk drives for storage, either a letter quality or graphics capable dot matrix printer or both, a graphic plotter, and perhaps a digitizer to facilitate data input. The foregoing applications are avoidable as programs on floppy disks that provide the micro with all the instructions to perform the software's intended function utilizing the user supplied data and the available system hardware. (Gifford 1987)

Using Distributed Network System, microcomputers can be networked together either by hard wiring or by a modem through a telephone line with other micros and all connected to a central storage device. This enables the micros to have the ability to communicate with larger mainframe computers, allowing the micros to utilize the immense capacity of time-sharing computers. The net effect of using the micro in such settings results in more convenient, flexible, and economical computer usage. (Gifford 1987; Thigpen 1981)

Computer Integrated Engineering System brings together the efforts of many specialty computer components, or work stations, into a multi-level, multi-user, multi-applications environment. The microcomputer acts as an intelligent terminal. (Thigpen 1981)

3.1.1.4 *Extent of Use*

The dispersion of computers among construction firms is an indicator of the extent of the use of technology by the construction industry. The extent of use is obtained and represented as a percentage of construction firms, using computers, over the whole population of firms. In addition, applications in which computers are utilized are used to determine the extent of use of computers in each application. The extent of use of each application is represented as a percentage of construction firms, using the computer in the application, over the whole population of firms utilizing computers within their operations.

3.1.2 COMPUTER APPLICATIONS IN CONSTRUCTION FIRMS

Many applications are appropriate for the computer use in construction firms. The following are most of these applications.

3.1.2.1 *Accounting*

The basic functions of accounting systems and procedures are to gather, process, and report on financial information. The end products are reports regarding the financial position of the firm at a specific date (balance sheet or statement of financial position), the results of operations during a specified period (statement of income), and cost data related to specific operations or projects (contract costs). (Freign 1980)

The computer performs basic accounting functions such as accounts receivable, accounts payable, general ledger, inventory, cash forecasts, and subcontractor control. Using time card input, the computer prepares payroll checks, periodic and special payroll reports, the payroll register and updates the employee master files. (Clough 1986)

3.1.2.2 *Spreadsheet Calculations*

The electronic spreadsheet is the premier example of user friendly software developed for the computer which enables a computer novice to easily, quickly and productively use the computer (Rounds 1984). Essentially, a spreadsheet represents a very large sheet of paper stored in the computer which is primarily designed as a very powerful 2-dimensional calculator where formulae are stored and the results displayed and printed (Parrett 1986). The latest development of spreadsheets is combining the electronic spreadsheet with database management systems and graphic applications (Rounds 1984).

The potential for spreadsheet programs and the variety of ways in which they can be used in construction are innumerable. Different usage includes cash-flow forecast, job costing and equipment replacement analysis (Parrett 1986). Spreadsheet can produce graphical illustration of data; information from tables prepared on a spreadsheet can be automatically converted into graphics and printed (Parrett 1986). Spreadsheet programs prepared for the contractor's use were found to be most popular as they offer the contractor the easiest short-term solution for computerized estimating (Skibniewski 1990). Spreadsheet is making vast changes in the application of the computer to construction estimating (Rounds 1984).

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3.1.2.3 *Scheduling*

Computerized scheduling systems maintain the detailed project schedule data and generate summary schedules and scheduling reports. Part of this process includes calculations relating to the scheduling network, such as start/complete dates, elapsed time, critical path, percent completion, remaining duration and expected completion dates. These systems can carry out resource leveling and cash flow requirement functions. (Vandersteen 1979)

A system with critical path capabilities can allow job site personnel immediately to analyze the effect of a particular change involving extra time on the overall project schedule. A properly programmed system allows the job site team to accurately appraise its progress on a daily basis. Problems critical to job progress will surface immediately, promoting management to solve them before they to any damage. (ASCE Task Committee 1985).

3.1.2.4 *Estimating*

An overview on estimating procedure can show the importance of utilizing computer systems. The estimator must take off and count all of the items on a print. About 90 percent of the items used by a contractor are the same, job after job. The estimator then applies labor and material factors to the items counted and perform multiplication's. Finally, the estimator collects similar items and prepares the summary for submittal. (Liewellyn 1984)

A computer-assisted estimation provides electronic methods to tally material take off from drawings in addition to a calculator mode which can help with takeoff computations (Larsen 1984). A range of hardware enhancement facilities are available including a digitizer for automatic takeoff from drawings, and touch tables allowing takeoffs by item description (Taylor 1985). Moreover, with the introduction of several computer-aided design programs for microcomputers, the possibility of direct computer-performed material quantity takeoff from drawings has become feasible (Stewart 1986).

3.1.2.5 *Word Processing*

An area of data processing that has recently come into its own is word processing. Word processing takes advantage of the computer's ability to manipulate words and characters and uses the computer as a storage, editing, and printing device. Various documents, such as standard letters, forms, reports, specifications, and bid documents can be written, edited, and stored using a computer. (Thigpenn 1981)

In construction, communication in one form or another whether it be to clients or consultants, subcontractors and suppliers or internally within the firm is an important issue. In this regard, the advantages of using the computer as a word processor are well known. (Parrett 1986)

A computer using word processing and database can be programmed to accept, store, and process a daily log information regarding date, whether work

is accomplished, changes, delays, etc. Another application is the storage and retrieval of pertinent clauses of the construction contract. Once the contract is entered into the computer, it can be queried and pertinent contract information produced. (ASCE Task Committee 1985)

3.1.2.6 *Database*

Database is a modern-day data management approach made possible by the advances in computer science and technology. It represents a system of higher level performance, and is considerably more efficient than previous data management systems. (Liou 1987)

Database programs can be used to store project information and provide a convenient means of examination and identification. Using the computer to store information provides the added facility of being able to transfer a large amount of information quickly and easily between locations, i.e., via the telephone system from site to site, or to head office. Database programs can have the ability to handle complex calculations thus extending their role beyond pure data storage into the field of management and company accounts, financial and statistical analysis. (Parrett 1986; Sucharich 1984)

3.1.2.7 *Linking with Field Office*

Field office computers can be linked to the main office. In such a direct tie to the main office, top-level management can have immediate access to field

operations (Rounds 1987). The field office can have instant access to data or programs via the site office telephone (Morris 1985). The nature of the construction industry means that good communications between construction sites and main offices are essential and the lack of such communications has traditionally been one of the industry's weakness (Mill 1985).

3.1.2.8 *Computer Aided Drafting & Design*

Graphics are used as an aid to give visual support to the numerical process. Computer graphics is essentially very simple coordinate geometry. Computer Aided Design and Drafting (CADD) is greatly enhanced by the use of graphics. The visual feel obtained for the problem is a valuable experience. Faster, more accurate plans can be drafted using the computer, increasing the quality and amount of work. (Thigpenn 1981)

Although CADD has been used for almost any design activity involving the use of a computer, it is mostly associated with the creation of graphics and the interaction of the graphics with engineering analysis involving arithmetic operations such as in stress analysis and management operations such as quantity takeoff and cost estimating. (ASCE Task Committee 1985).

3.1.2.9 *Risk Analysis*

Construction work by nature is hazardous, and accidents are frequent and often severe. Risk management may be defined as a comprehensive

approach to handling exposure to loss. Risk management includes the analysis of many items. Risks that apply to the construction process are recognized and identified. The analysis of different degrees of exposure to those risks is a very important issue. Decisions about protection against risk depend on such analysis. (Clough 1986)

3.1.2.10 *Process Simulation*

Process analysis is an emerging area for which computers can be adapted. The primary method of analysis being utilized is computer simulation. Process modeling and simulation can be made more accessible to the construction manager where computers with acceptable computational value are available. (ASCE Task Committee 1985)

3.1.2.11 *Expert System*

Computer programs can capture the knowledge of an expert in a given field of specialization and make it usable by non-experts, achieving a high level of performance similar to that of a human expert. An expert system embodies in a computer the knowledge-based components of an expert skill in such a form that the system can offer intelligent advice, and on demand, justify its own line of reasoning. (Ntuen 1987)

3.1.3 FACTORS AFFECTING COMPUTER UNDER-UTILIZATION

Construction firms are becoming more conscious of computers. Several studies showed overall awareness of the computer's role. Many contractors now accommodate these machines in their firms. However, computers might not be utilized fully by contractors. Some causes for such under utilization and for fears of utilizing computers were identified:

3.1.3.1 *Cost of Computer and Software*

Although the cost of computer systems ranges according to the type of systems used, the cost of hardware and software may hinder the utilization of computers. The current associated cost of some computer systems may represent a significant proportion of a small contractor's budget. (Stewart 1987)

3.1.3.2 *Cost Effectiveness*

For non-small firms, computer implementation cost may not be concern. However, difficulties in assessing cost effectiveness or return on the computer system can cause the contractor's desire to eliminate costs which can not "pay their way". In other words, the cost may not be justified. (Skibniewski 1990)

3.1.3.3 Lack of Computer Experience

The lack of previous computer experience by contractor personnel caused the slow adoption of computer methods. The cost of hiring new personnel experienced in computer applications to construction would not be preferable for the contractors. (Skibniewski 1990)

3.1.3.4 Unsophisticated Management Methods

Contractors may not feel that their current scheduling or estimating, for example, needs were demanding enough to enlist computer assistance. This may hinder them from utilization of technology in their management tasks. (Skibniewski 1990)

3.1.3.5 Difficulty in Selecting the Right System

The lack of a dependable, comprehensive, comparative coverage of the available software and hardware in the literature prepared for construction contracts make it difficult to select the proper system. (Skibniewski 1990)

3.1.3.6 Restrictive Forms of Output

Readability and clarity of printouts are critical for the contractor. Manual adjustment to the computer format may be necessary for data

presentation. Such drawbacks might affect a decision to utilize a computer system. (Skibniewski 1990)

3.1.3.7 *Lack of Training*

Successful transition from manual procedures to the use of computer systems depends to a large extent upon knowledgeable users. Many construction firms may run into problems when they start in computing. Others experience may be remarkably trouble-free. This is due to preparation made for such a move. An important aspect of preparation included training people prior to the system being installed. (Skibniewski 1990; Stewart 1987)

3.1.3.8 *Lack of Computer Standards*

The extreme lack of standardization between the various firms in the computer industry is an important issue (Morris 1985). The lack of industry standards for computer hardware and software makes communications between systems difficult (Stewart 1987).

3.1.3.9 *Hardware and Software Incompatibility*

Hardware and software incompatibility can greatly hinder a contractor's ability to either utilize software already in his possession or new software as it becomes available. Contractors might be dissatisfied with the inability to send information from the payroll to a spreadsheet program, for example. (Skibniewski 1990)

3.2 DATA COLLECTION

The data required for this study were collected from the classified construction contractors in Saudi Arabia. The key information was from the top manager of the construction firm.

A written questionnaire is the method used for collecting the necessary information (Appendix A). Some parts of the questionnaire are taken from a questionnaire which was prepared to survey computer utilization by construction contractors in Central Indiana, U.S.A. (Appendix B). It was conducted by Prof. Mirosław Skibniewski at Purdue University.

The questionnaire (Appendix A) is divided into three main parts. The first section contains questions about the firm regarding its size, capacity, type of work performed, etc. The second part contains questions regarding the use of computers by the firm. The respondent is asked to check those functions the firm is using the computer in, along with those functions that he wants to be able to perform with the computer. In addition, some open-ended questions are asked to evaluate the use of computer for different functions. The last part of the questionnaire contains a list of factors that contribute to the under-utilization of computers. In this part, a scale from "1" to "5" is used to let the respondent assess the effect of each factor, where "1" reflects no effect, and "5" reflects very major effect.

3.2.1 SAMPLE SELECTION

The total population of the study is all the classified construction firms in Saudi Arabia. A sample is selected to represent the whole population. Three conditions are maintained in order to ensure that the sample is representative of the population:

1. Equal chances: every firm has the same chance to be selected.
2. Appropriateness: the sample must precisely reflect the characteristics of the population.
3. Independence: every sample is selected independent of another sample.

The method of sampling used is random sampling. Random numbers were used to select the sample contractors from the contractors list, prepared by The Contractors Classification Agency at the Ministry of Housing and Public Works. A simple computer program using "Basic" is used to generate the random numbers. These numbers are matched with the serial numbered list of contractors to get the randomly selected contractors to whom the questionnaire will be sent.

3.2.2 SAMPLE SIZE

According to the Contractors Classification Agency, the number of classified construction contractors in Saudi Arabia is 1381, which is the whole

population. The size of the sample is determined using the following formula (Kish 1965):

$$n = n' / (1 + (n'/N))$$

where, $n' = S^2/V^2$

N = Size of the finite population.

S^2 = The variance of population elements, estimated by $S^2 = P(1-P)$ and the maximum value is chosen at $P = 0.5$.

V = Standard error (i.e. standard deviation of the sampling distribution), reasonable standard error = 0.05 (for the error of 0.1 at 95% confidence).

P = Proportion of the population elements that belong to the defined category.

This generated a sample size of 93. Assuming a response rate of 25 to 35 percent as per previous studies, a total of 300 questionnaires were sent via mail to different regions in the Kingdom. The number of questionnaires received was 93. Hence, the actual response rate is 31 percent.

3.3 DATA ANALYSIS

The information gathered from the questionnaire was analyzed statistically. The data was tabulated and summarized in a compact format in order to be studied and analyzed by descriptive statistical analysis. Also,

statistical analysis was undertaken through applying the cross tabulation procedure for calculating the percentage associated with the findings. Other statistical techniques were incurred and utilized in this study including ranking, scoring and correlation. These statistics are used for calculating and presenting the survey results. Analyses were conducted using the SAS Program. The analysis of the data is finally represented by tables, diagrams, monographs and other figures.

The relative importance index is established for factors that hinder computer utilization. Its aim is to measure the importance of each factor from the evaluators' point of view. Since these factors are evaluated by both contractors using computers and those not using them, and they create two sets of ranks, the Spearman Rho Analysis is applied to provide a numerical index of the relation between the two sets of ranks. Spearman Rho ranges in value from -1 to +1. It indexes the linear relation between the two sets of ranks. Positive value indicate that high ranks tend to be associated with high ranks and negative values indicate that high ranks on one variable tend to be associated with low ranks on the other. The Rho coefficient is obtained by the following formula (Dominowski 1980):

$$\text{rho} = 1 - ((6ED^2)/N(N^2-1))$$

where,

D = differences between rank on one variable and rank on the other variable for an individual factor.

N = Number of factors.

CHAPTER 4

RESULTS & ANALYSIS

This chapter presents the characteristics of the construction firms who participated in the study, the extent and types of computers that are used by contractors, and functions that computers are involved in within contractors' business operations. It also advances the factors that are responsible for the reported extent of use of computers in the construction industry.

4.1 CHARACTERISTICS OF THE PARTICIPATING FIRMS

The Construction Engineering and Management program at King Fahd University of Petroleum and Minerals mailed 300 questionnaires to randomly selected construction contractors operating in different regions of Saudi Arabia. A total of 93 contractors completed and sent in the questionnaires. The rate of return is 31 percent. The return is always low in such studies which depend on mail survey.

The results indicated that 30 percent of the participating contractors are building contractors, where only 5 percent are involved in engineering projects. However, most of the contractors were found to be working in two or more types of construction.

For the purpose of understanding and explaining computer use in the construction industry, the contractors are classified into small, medium, and large size on the basis of their annual business volumes. The Chamber of Commerce and Industry suggested in Al-Egtisad Magazine and in the Directory of Construction Contractors in Saudi Arabia to classifying contractors as follows:

- a. A contractor is considered small if his annual business volume is SR 25 million or less.
- b. A contractor size is considered medium if his annual business volume is greater than SR 25 million but less than SR 55 million.
- c. A contractor is considered large if his annual business volume is SR 55 million or more.

The application of the above system to the participating contractors classifies them into categories as shown in table 1. The distribution of the contractor's size represents the actual distribution where small contractors constitute the majority of contractors and large contractors constitute the smallest percentage of contractors.

Table 1: Size Categories of Participating Contractors

SIZE OF CONTRACTOR	NO. OF CONTRACTORS	PERCENT FROM TOTAL
SMALL	58	62%
MEDIUM	21	23%
LARGE	14	15%
TOTAL	93	100%

The majority (63 percent) of the participating contractors are family owned type of entities. Table 2 shows the type of ownership of the participating contractors.

The results indicated that about 50 percent of the participating firms, mostly small contractors, started business during the last decade. Most of the medium firms and the large size firms started before the 1980's. This result might be traced to the drop in demand for large construction projects, coupled with the completion of most of the infrastructure in the Kingdom in the early 1980s. This caused the establishment of large construction firms to be a less attractive investment option.

Almost one half of all the participating firms are operating in only one region of the Kingdom: East, West, South, North or Central. The other half of the firms operate in two or more regions and/or internationally. Only 1 small firm, 12 medium firms, and 3 large firms indicated that they operate outside the Kingdom as well as inside the Kingdom. Fifty percent of small and medium size firms have no branch offices other than the head office, whereas only one large firm reported not having other branch offices.

4.2 EXTENT OF COMPUTER USE

At the beginning of the study, it was anticipated that computers were used by all construction contractors. This expectation resulted from the belief

Table 2: Types of Ownership of Participating Contractors

TYPE OF ENTITY	SIZE OF CONTRACTOR			TOTAL
	SMALL	MEDIUM	LARGE	
FAMILY OWNED	44	12	3	59
PARTNERSHIP	11	6	2	19
CORPORATION	1	0	3	4
SAUDI-SAUDI JOINT-VENTURE	1	0	0	1
SAUDI-FORIGEN JOINT-VENTURE	1	3	6	10
TOTAL	58	21	14	93

that a computer could be used at least as a word processing tool since costs of some computer systems are not more than those of good typewriters.

The results, however, indicated that only fifty-one of the contractors who participated in the study (about 55 percent) are using computers in their business operations compared to forty-two contractors who reported not using computers. Table 3 shows the extent of computer use through the three different categories of contractors. Computers are used to even less extent in small firms where only 41 percent of the small firms are using them. Sixty two percent of the medium firms are using computers. None of the large firms participating in the survey reported not utilizing the systems. All large firms are using the computers in their operations. A conclusion might be drawn when looking to the extent of use of computers within the range of contractors' sizes. The utilization of computers is directly proportional to the size of the firm. As the size gets greater, the level of use is higher. This phenomenon might be a result of the fact that large firms handle large size projects, which need greater control and deal with different complex operations, ending up with a greater demand for more advanced tools such as computers. Moreover, experts in computers, in the construction industry, may be attracted to larger size firms. Smaller firms might not be able to allocate large portions of their budget for computerization and can not attract computer experienced professionals, resulting in a lower level of utilization.

Most of the participating construction firms who use computers introduced computer system technology into their operations during the last

Table 3: Extent of Computer Use for Different Categories

SIZE OF CONTRACTOR	COMPUTER USE			
	USING		NOT USING	
	NUMBER	PERCENT	NUMBER	PERCENT
SMALL	24	41%	34	59%
MEDIUM	13	62%	8	38%
LARGE	14	100%	0	0%
TOTAL	51		42	

decade. This fact may indicate that contractors are moving towards the computerization of their operations to cope with the new technology. The highly competitive environment created during the beginning of the 1980's due to the economic situation, resulting in a drop in the demand for construction work may be traced as a motive for construction firms to looking for more competitive and reliable tools, such as computers, in order to keep operating in business. Also, it may be the result of the significant drop in the prices of computer systems.

4.2.1 TYPES OF COMPUTERS

Different types of computer systems are available for use by construction firms. The survey indicated that all the main types of computer systems: mainframe, mini, and micro computers are used in construction firms operations. Table 4 shows the reported use of the three types of computers according to the three contractors' sizes. The following paragraphs present detailed discussion on the extent of use associated with each type of computer.

4.2.1.1 *Mainframe Computers*

The results indicated that the mainframe computer is not used widely by construction firms operations. Only two construction firms who use computers reported having Mainframe Computers. These two firms are large construction firms. This result is expected, since only large firms can afford this type of system in terms of costs. In addition, the two firms, which constitute less than

Table 4: Use of Computer Types by the Participating Contractors

SIZE OF CONTRACTOR	TYPE OF COMPUTER SYSTEM		
	MAINFRAME	MINICOMPUTER	MICROCOMPUTER
SMALL	0	1	24
MEDIUM	0	1	12
LARGE	2	1	14
TOTAL	2	3	50

4 percent of all firms, utilized different types of systems along with the mainframe systems. Since it is expected that large firms have more manpower than smaller firms, the use of one database, for example, for many users at the same time, a feature offered by the use of mainframe, may be the reason for the utilization of such systems. They may also be used to run programs that require large memory (RAM).

4.2.1.2 Minicomputers

The study indicated that only 3 firms, constituting less than 6 percent of all firms using computers, are using minicomputer systems. When minicomputers are utilized in these firms, other types are also used along with the minicomputers. The need for systems that offer features offered by mainframes but with less cost, might be the cause for the selection of minicomputer systems. Minicomputers can perform all of the functions of mainframe computers but with a slower processing speed, smaller memories, and less input/output and data communication capabilities. They also offer the feature of working as individual work stations.

4.2.1.3 Microcomputers

The use of microcomputers is far behind any comparison with the other systems: mainframe and minicomputers. The study indicated that most of the construction firms, who are using computers within their operations, are using microcomputer systems. Only one firm reported not using such systems.

Microcomputers are used even in construction firms using mainframe or mini computers. The low cost of micros compared to other systems might be the reason for the high level of utilization. The microcomputers offer features that can not be offered by other systems within the same range of systems. These include the ability to work as stand alone systems as well as intelligent terminals in network systems, to communicate with larger mainframe computers allowing the micros to utilize the immense capacity of time sharing computers, and to utilize much more software with low costs.

4.2.2 HARDWARE & SOFTWARE SELECTION

Selecting the hardware and software for computer systems constitutes a major part of the implementation of computer technology in the contractor's business operations. The contractors participating in the study were asked to determine what method(s) were used for such selection. They were provided with a list of the most likely methods of selection that could be used. These included magazines, brochures, personal contact, articles, books, sales persons, and consultants. Personal contact is the most popular method by which construction contractors in Saudi Arabia select both the computer systems and the application programs. Computer experts are the second most popular method by which construction contractors choose the proper hardware and software. The third method that is used to select hardware and software is through sales persons. Books, articles, and magazines occupy the other end of the spectrum. This method is not widely used in the selection process maybe because most of the literature is written in English and highly technical. These

facts also apply when it comes to small and medium size firms. Large firms, however, depend on consultants for selecting their hardware and software systems, reflecting the tendency of large firms toward more professional and systematic selection methods. One participating large contractor indicated that he uses market survey to select the necessary computer systems.

4.2.3 TRAINING ON THE USE OF COMPUTER SYSTEMS

The success in achieving the goals that are desired from a computer system depends on the operator's skill and knowledge of both computer operating systems and the computer programs used. The desired skill could be obtained by enrolling potential users in a training program. Contractors as well as other computer users have training programs such as short courses, tutorials, and on job training which are available to them. The participating contractors indicated that they have developed in-house training programs. In these programs, the most experienced employees in computer systems and programs are assigned the responsibility of training other employees in the firm. The second most popular training program that contractors indicated using is enrolling their employees in short courses that are organized by educational agencies. Twenty participating contractors who use computers train their employees in the use of computer systems through in-house and out of house short courses. It seems that the contractors may choose the training programs that are less expensive. The hiring of new staff who have experience in computer use and obtaining the assistance of employees from other firms are

two other training methods that are indicated by some participating contractors.

4.3 COMPUTER APPLICATIONS

Computer technology has a wide range of applications for a business setting. The study investigated the different applications of computers in construction firms which use computers. The participating contractors who use computers were given a list of functions that constitute the possible uses of computers in their organizations. These functions are: accounting, spreadsheets, scheduling, estimating, word processing, database, linking with field offices, computer aided design and drafting, risk analysis, bidding strategies, and expert systems. The participating contractors were asked to indicate those functions that are computerized in their organizations. Table 5 shows the percentage of use of each function by all computer users as well as the three different sizes of contractors. Each of the applications of the computer will be discussed in details in the following paragraphs.

4.3.1 ACCOUNTING

The results indicated that computer systems are widely used by construction contractors for accounting purposes. The results indicated that the use of computers in accounting functions is ranked first as compared to other functions that the computer systems may be used for (table 5). The results indicated that computerizing accounting functions of some construction firms was the major reason for purchasing computer systems. All large size

Table 5: Utilization of Computers for Various Software Functions

SOFTWARE FUNCTIONS	PERCENT OF UTILIZATION BY CONTRACTORS			
	ALL	SMALL	MEDIUM	LARGE
ACCOUNTING	88	79	91	100
PAYROLL	88	79	91	100
GENERAL LEDGER	61	33	82	86
ACCOUNTS RECEIVABLE	61	38	64	93
ACCOUNTS PAYABLE	61	38	64	93
BALANCE SHEET	57	38	55	93
INCOME STATEMENT	59	42	55	93
SPREADSHEET CALCULATIONS	49	33	55	93
ESTIMATING	49	25	36	93
JOB COSTING	45	29	36	71
CASH FLOW	49	25	55	86
EQUIPMENT REPLAC. ANALYSIS	18	21	18	14
GRAPHICS	43	33	36	64
SCHEDULING	61	38	73	93
RESOURCE LEVELING	45	21	36	93
CASH FLOW REQUIREMENTS	33	13	36	64
ESTIMATING	35	29	27	57
WORD PROCESSING	59	54	64	64
CONTRACT LANGUAGE RETRIEVAL	35	25	27	64
PROCESS DAILY LOGS	51	54	45	57
DATABASE	67	58	55	100
STAFF INFORMATION	67	54	55	100
EQUIPMENT INFORMATION	51	38	36	86
PROJECT INFORMATION	61	58	36	86
WAREHOUSE INFORMATION	43	25	36	79
LINKAGE WITH FIELD OFFICES	16	0	18	36
COMPUTER AIDED DESIGN&DRAFTING	20	8	9	50
RISK ANALYSIS	20	4	27	43
BIDDING STRATEGIES	0	0	0	0
EXPERT SYSTEMS	0	0	0	0
OTHERS	10	13	0	14

contractors reported implementing computerized accounting functions, whereas about 90 percent of the medium size contractors and about 80 percent of the small size contractors have their accounting functions computerized.

In this major function, computers are used for payroll processing, general ledger development, tracing of accounts receivable and accounts payable, and producing balance sheets and income statements. It is noticed that large contractors are using computers in all aspects of accounting procedures. The domination of the computer in this function may be attributed to its ease, accuracy, and efficiency in producing valuable information for business decisions. The payroll issue dominates the computerized accounting among the three sizes of contractors. This domination may result from the fact that most of the contractors surveyed are building contractors who are characterized as labor intensive. The balance sheet and income statement are two financial documents that are produced periodically to show the financial status of a firm. These two documents are important for the owners and for Zakat purposes. The large contractors which are mostly partnership type of organizations are using computers extensively in producing these two documents. Medium and small contractors are using computers to a lesser extent in the two elements of accounting. The majority of the small and medium size contractors are family owned type of organizations.

The results indicated that speed, minimal error, and quality of presentation were the basic advantages gained when dealing with the computerized practice of accounting. Keeping accounts up-to-date and

generating immediate reports of the up-to-date financial position were important features of computer usage in accounting. Some firms stated that the use of computers in accounting limited the number of accounting personnel, hence reducing expenses.

4.3.2 SPREADSHEET

Electronic spreadsheets can be used in a variety of applications within a construction firm. The flexibility of the spreadsheet in customizing an operation for calculation and graphics gives it a high potentiality for use in the construction industry. Unfortunately, the results indicated that about 49 percent of the computer users in the survey, mostly large size contractors, make use of the power of spreadsheet. The large contractors are using spreadsheet in estimating, job costing, cash flow, equipment replacement analysis, and graphics. Few medium and small size contractors are using spreadsheet in the above operations. It seems that large contractors attempt to make use of computers in all aspects of their operations.

4.3.3 SCHEDULING

The construction firm prepares schedules where a significant amount of data collection, processing and interpretation is required. Computerized scheduling systems maintain detailed project schedule data and generate the required schedules and reports.

The study indicated that 61 percent of all contractors are using computerized scheduling techniques. Most of large firms utilize computers in this function. The number of firms practicing computerized scheduling gets lower, however, when it comes to small and medium firms.

This low usage of computerized scheduling among the majority of construction firms - small and medium firms - may be justified. Elaborate presentations, such as precedence diagrams or network formats might not be very popular with the contractors, specially the small ones. A simple bar chart outlining the early start and finish dates represents a simple option. In addition, contractors' scheduling requirements might not be demanding enough to justify the cost of sophisticated scheduling programs. Those factors might have contributed to the lack of utilization in scheduling. More advanced applications such as resource leveling had little utilization by construction firms.

The study showed that working with different alternatives and, hence, a better decision making was the main advantage of using computers in scheduling. Any change to the schedule was reported easier and more accurately using the computer over normal methods. Quick reporting and instant analysis of the current situation were of great value for contractors. Getting easy and quick results in time, cost, cash flows and bar charts were other features of computer utilization in scheduling.

4.3.4 WORD PROCESSING

Most of the contractors reported purchasing the computer systems originally for word processing. This fact remains constant when comparing the three different categories of firms. Computerized editing, updating, inserting, and printing of documents and records are the most widely appreciated applications among word processing applications. Using the word processor for retrieval of contract items had little interest for the construction firms.

Editing of documents was stated as the major advantage of computerized word processing. Other support features, such as spell checks, improved the quality of document generation. The ability to store all documents, letters, indices, and mailing lists and to reuse them, was of great value to the firms. The computer, as stated by one firm, can take care of anything that a regular typewriter might be used for.

4.3.5 DATABASE

Computerized database ranked as the second most widely computerized function performed by construction firms. All large firms are utilizing database software within their operations. About half of the medium firms and small firms reported using such programs. All the users of database software are using it for storing information related mostly to their staff, equipment, projects, and inventory of warehouses. The use of database programs was concentrated on staff and project information. Warehouse information stored

on a computerized database format was ranked low among database applications.

The study showed that the collection, processing and utilization of data for costing and estimating purposes was less tiresome and more error-free and that this was a major advantage of the use of database function. The ability to retrieve information very quickly and rapid report generation were valued by construction firms. Computerized filing systems provide a reliable and more secure option. Database was used for personal records of employees, equipment information, and old projects information. Using computers has resulted also, in lowering the manpower that used to be handling such immense and tedious jobs.

4.3.6 ESTIMATING

Estimating by computer can be performed by using spreadsheets and developed estimating software (vendor written). The results indicated that the vendor written type of estimating programs are used only by one third of all firms using computers. This percentage does not differ widely among the three different categories of firms. This low use of already developed cost estimating programs might be contributed to the wide range of estimating methods available and to the different considerations accounted for in the estimating process from one contractor to another. The use of a much easier, less expensive, and much simpler alternative such as the use of spreadsheet

programs for estimating, might add to the cause of low usage of vendor-written estimating packages.

The study indicated that storing and updating standards and information were made possible when using computers in estimating. Firms stated that computers have replaced the enormous paper work of references and cost indices. The ability to produce a quick, error-free estimate was a great privilege for firms using this technology. Computerized estimating helped in generating more alternatives of estimates for comparison and decision making. Last minute changes of prices or quantities were possible. The use of computers allowed for some operations that were not possible when using manual methods. Such operations are last-minute changes of prices and quantities.

4.3.7 OTHER FUNCTIONS

The study revealed that construction firms placed little value on computerizing other support functions, such as risk analysis and linking with field offices. An area with a potential advantage is the fast, and instant communication between the firm's main office and construction sites. The study showed that one third of the large contractors are using this feature. None of the small and medium sized contractors was reported to communicate with the site by the means of computers. The greater complexity of projects handled by large firms, and the need for handling and processing, of data and the need for faster decision making may be the reason for limiting the use of computers to only the larger size contractors. CAD function is utilized by only one quarter

of the firms. Most of the large firms are using CAD packages whereas only a few firms from the other two categories are interested in such an application. None of the contractors who participated this study showed utilization of computers in bidding strategies or expert systems. Other functions that were added by the responding firms included logistics, material control, accountability system for tools and equipment, and suppliers and subcontractors information.

4.4 FACTORS AFFECTING COMPUTER UTILIZATION

The participating contractors were asked to assess the impact of a list of factors that were perceived as causes for low use of computers by construction firms. All respondents, including those who are not using computers, were asked to value the effect of each of them (figure 1). Figure 2 and figure 3 show the assessment of those factors by contractors using computers, and by those not using computers. Comparing the two figures, it is obvious that they are almost similar. In other words, contractors using computers and those who are not using computers evaluated the effect of factors similarly. The evaluation of the factors by all the participating contractors according to their sizes is also shown. Figure 4 shows the assessment of the factors by all large contractors participating in this study, Figure 5 shows the assessment made by all medium contractors, and figure 6 shows the assessment by all small sized contractors. The same result occurs when comparing the three different size categories of contractors. The assessments of these factors look, generally, the same for the different contractors' sizes.

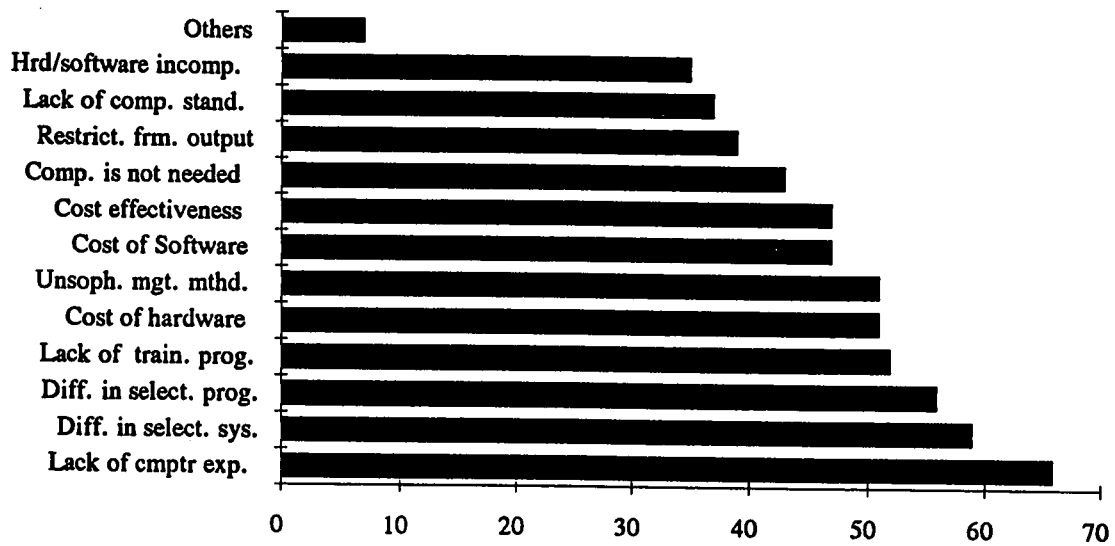


Figure 1: Factors Affecting Under-Utilization by all Contractors

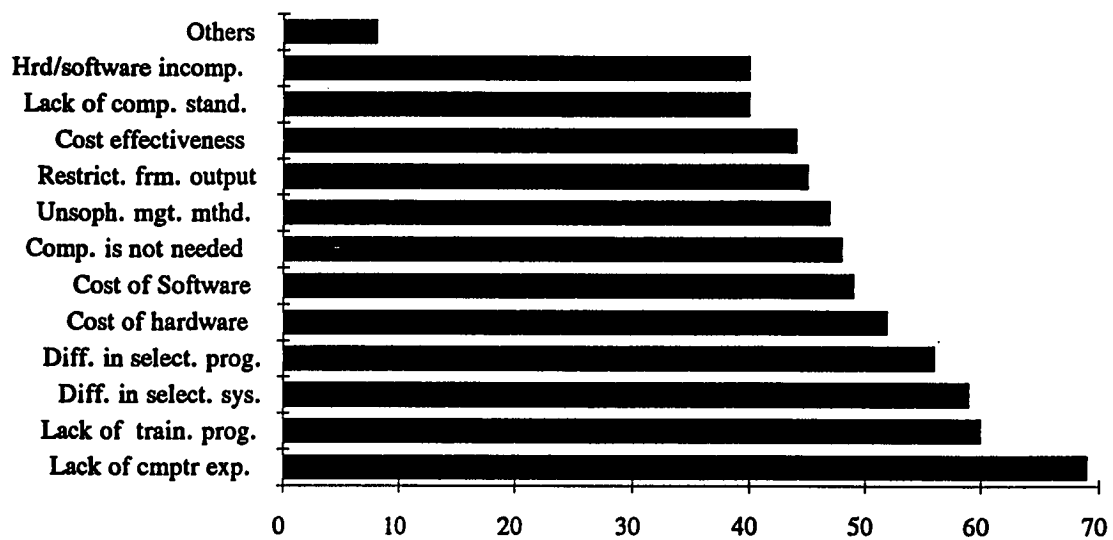


Figure 2: Factors Affecting Under-Utilization by Contractors Using Computers

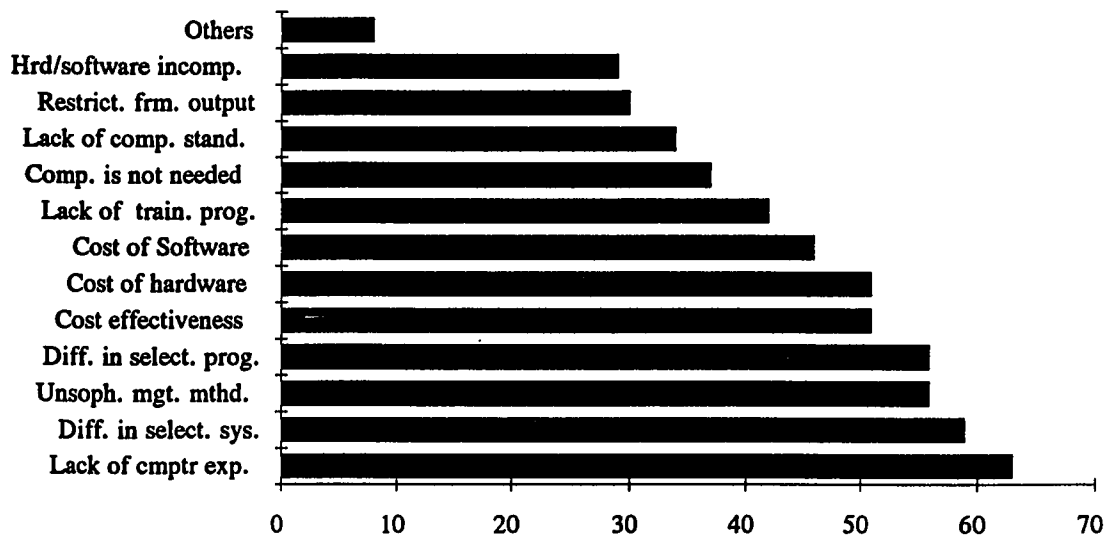


Figure 3: Factors Affecting Under-Utilization by Contractors not Using computers.

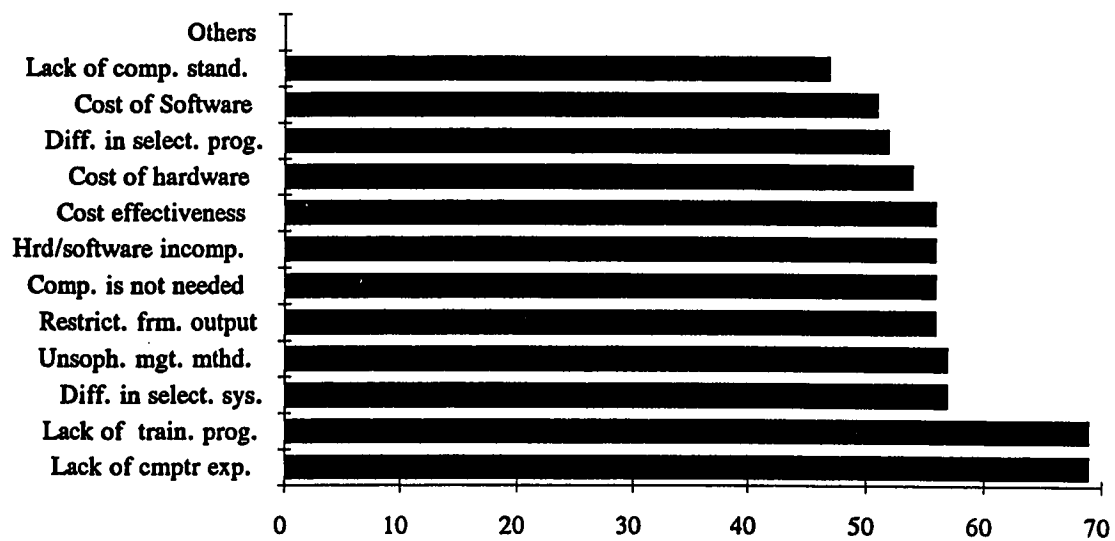


Figure 4: Factors Affecting Under-Utilization by all Large Contractors

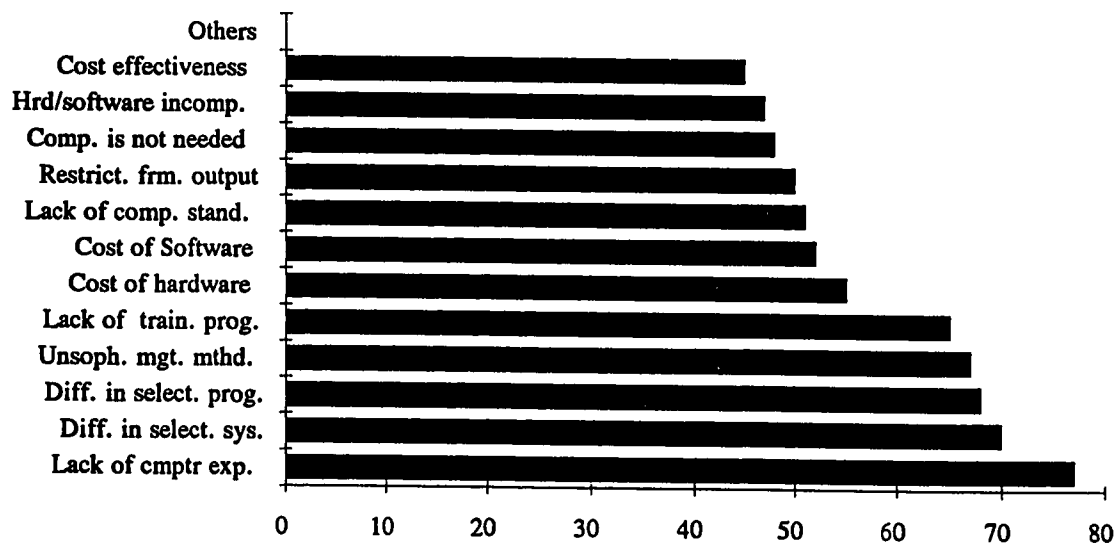


Figure 5: Factors Affecting Under-Utilization by all Medium Contractors

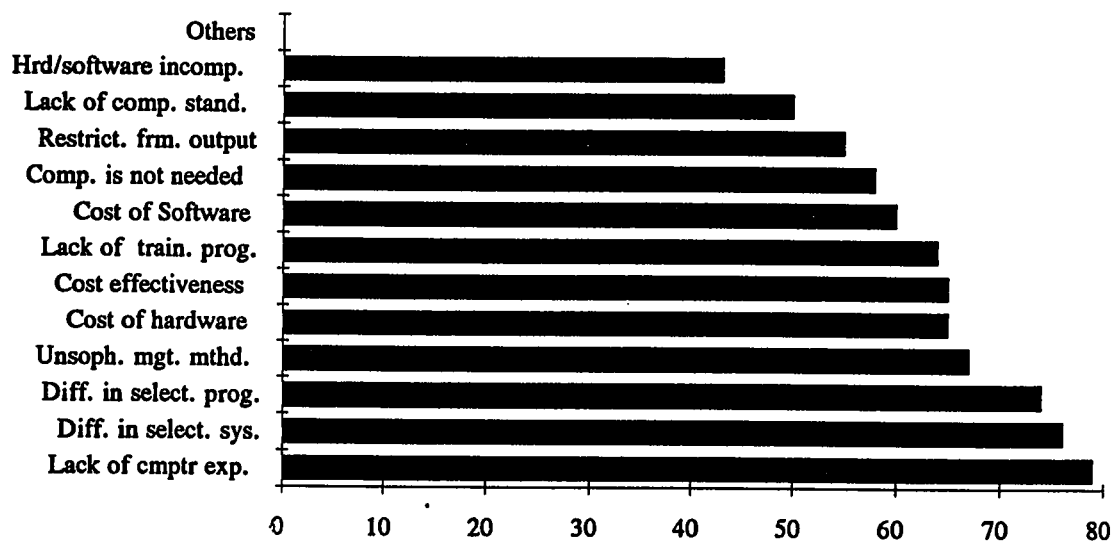


Figure 6: Factors Affecting Under-Utilization by all Small Contractors

In order to draw quantitative conclusions for these results, another method of analysis is required. Since the assessments of these factors can be expressed in ranks, the spearman rho analysis is applied. It provides a numerical index of the relation between two sets of ranks. The value of spearman rho coefficient ranges in value from +1 to -1. Positive value indicates that high ranks on one list of factors tend to be associated with high ranks on the other. Therefore, the ranks of the factors that affect computer utilization which are assessed by all participating contractors, all different sizes, and to all those who are using computers or those not., are established. These sets of ranks are shown in table 6. In order to establish a numerical index for the assessment of the factors by computer users and non computer users, the analysis is applied to all participating contractors who use computers and those who are not. It is also applied to small contractors who use computers and those who do not, and to medium contractors who use computers and those who do not. The values of the rho coefficient for these sets of ranks are found to be +0.75, +0.73, and +0.70 respectively. Such positive values indicate similar tendencies for associations of ranks by those contractors who use computers and those who do not. When comparing the assessments made by the different size categories of contractors, the value of the coefficient is found to be +0.85 when considering ranks made by all small and all medium sized contractors, +0.60 when considering ranks made by all small and all large contractors, and finally +0.51 when considering ranks made by all medium and all large contractors. These values indicate the same tendency for assessment of the factors by the different contractors' sizes. However, such tendency is found to be greater between small and medium contractors.

Table 6: Ranks of Factors by Contractor's Assessments

FACTORS	RANKING BY ALL CONTRACTORS			RANKING BY DIFFERENT CONTRACTORS' SIZES											
		CONTRACTORS		SMALL			MEDIUM			LARGE					
		USE	NO USE	USE	NO USE	USE	NO USE	USE	NO USE	USE	NO USE				
LACK OF COMPUTER EXPERIENCE	1	1	1	1	1	1	1	1	1	1	1	1	1	.	
DIFFICULT. IN SELECT. RIGHT SYS.	2	3	2	2	2	2	2	4	3	4	3	4	4	.	
DIFFICULT. IN SELECT. SOFTWARE	3	4	3	3	3	3	3	3	2	10	2	10	10	.	
LACK OF TRAINING PROGRAMS	4	2	8	7	4	8	5	2	6	2	6	2	2	.	
COST OF HARDWARE	5	5	6	5	6	5	6	6	5	9	5	9	9	.	
COST OF SOFTWARE	7	6	7	8	7	7	7	7	7	11	7	11	11	.	
COST EFFECTIVENESS	8	10	5	6	9	6	12	9	4	6	9	4	6	.	
UNSOPHISTICATED MGT. METHOD	6	8	4	4	11	4	4	5	12	3	5	12	3	.	
COMPUTER IS NOT NEEDED	9	7	9	9	5	9	10	12	9	5	12	9	5	.	
RESTRICTIVE FORMS OF OUTPUT	10	9	11	10	8	11	9	8	10	7	8	10	7	.	
HARD. & SOFTWARE INCOMPAT.	12	11	12	12	12	12	11	10	8	8	10	8	8	.	
LACK OF COMPUTER STANDARDS	11	12	10	11	10	10	8	11	11	12	11	11	12	.	
OTHERS	13	13	13	13	13	13	13	13	13	13	13	13	13	.	

when applying a T-test at 95 percent confidence level of the null hypothesis that contractors do not agree on the assessment of the thirteen factors hindering from computer use, the value generated is found to be 0.566. This means that any two groups of contractors agree on the assessment of factors if the rho coefficient value, resulted from their ranking, exceeds the 0.566. Since the coefficient values for ranking, made by contractors who use computers and those who do not among all sizes, are greater than 0.566, the agreements on the assessments occur. This also applies for the assessments made by the different sizes of contractors except when comparing the assessments made by all large and all medium contractors since the rho coefficient resulted from these two ranks is +0.51 which is less than 0.566.

4.4.1 LACK OF COMPUTER EXPERIENCE

Lack of computer experience was rated as the main cause for computer under-utilization. This fact remains unchanged among the three different categories of firms and is important in showing whether such firms are using computers or not using them. Such a result may reflect the absence of information regarding computer usage in the construction industry.

4.4.2 DIFFICULTY IN SELECTING THE RIGHT SYSTEM

The participants indicated that difficulty in selecting the right computer system was a major contribution to low usage of computers. It was ranked

second among factors hindering computer use. The high ranking of such a cause may be the result of the lack of professional assistance in computers needed for the firms to implement computerized applications. All classes of contractors, whether they are using or not using computers agreed on the importance of such factor.

4.4.3 DIFFICULTY IN SELECTING SOFTWARE PROGRAMS

The contractors who participated in this study complained about the massive problem they experience when they attempt to find and implement application programs that satisfy their needs. This indicates that there is a huge communication gap between computer professionals and construction contractors. This gap is smaller between large contractors, who ranked this factor very low, and the computer professionals. A large contractor may be able to choose and implement software easily due to the presence of experienced computer personnel in the firm.

4.4.4 LACK OF TRAINING PROGRAMS

When comparing the rating of the lack of training between firms using computers and those not using computers, one major conclusion is noticed. This factor is rated more as a cause for under-utilization by the contractors who are using computers. Such a result explains the difficulties facing construction firms after introducing new technology into their operations. In other words,

this fact will not be known by a firm which did not go through the introduction of the computer system in its operation.

This fact stays the same when comparing the different sizes of contractors. It is indicated that as the firm size gets smaller, the importance of such factor gets lower also. The exposure of larger firms to computer markets and what is offered may be a good reason for such conclusion.

4.4.5 COST OF HARDWARE

The cost of a computer system depends on the type of computer and required specifications; such as hard disk capacity, CD ROM, ..etc. The cost of such systems may hinder the utilization of computers. The results indicated that the computer cost makes a large contribution to the low use of computers specially among small sized contractors. A computer system may represent a significant proportion of a small contractor's budget.

4.4.6 COST OF SOFTWARE

Cost of computer software was ranked lower when compared to the costs of hardware. As with the decision for computerization and the justification for hardware costs, costs associated with application programs may be easily justified. However, cost of some software may be considerable hindrance to utilization for smaller firms with relatively limited budgets.

4.4.7 COST EFFECTIVENESS

Cost effectiveness is rated high by contractors who are not using computers, specially small sized firms. For these contractors, the cost associated with the use of computers may be of concern to them. It seems that those contractors can not assess the cost return of investment or the effectiveness of the computer system. This inability may lead them to the decision of not investing and to eliminate costs which may not be justified.

4.4.8 UNSOPHISTICATED MANAGEMENT METHODS

The absence of sophisticated management was rated very low by large firms as a cause of computer under-utilization. Such a result explains the complexity of construction firms' operations performed by large firms, handling many projects of greater complexity. Such a factor is rated differently by firms using computers and those not using computers. This factor was rated low by firms using computers. Firms that are not using computers showed that the absence of sophisticated management methods is a major hindrance to computerization. Such a conclusion may be traced to the fact that firms not using computers had not experienced having the technology in their operations. Hence, they do not know how their operations can be more effective with the use of computers.

4.4.9 COMPUTER IS NOT NEEDED

The results indicated that one of the major factors hindering the use of computers in the construction industry is the belief in its need. Large contractors consider this factor as a major hindrance to computer use. This belief may exist because of old management who think of computers as a threat to their existence. In addition, it seems that benefits could be obtained from the use of computers in construction firms.

4.4.10 RESTRICTIVE FORMS OF OUTPUTS

Reluctance to computerize may be the result of low expectations from the use of computers in generating outputs. More complex and advanced outputs may not be of concern to construction professionals. However, such a factor was rated high as a major hindrance to computer use by those firms using computers.

4.4.11 HARDWARE AND SOFTWARE INCOMPATIBILITY

The hardware and software incompatibility factor was rated low. Such a factor may be relevant if firms were exposed to more advanced applications, involving different types of software programs or hardware.

4.4.12 LACK OF COMPUTER STANDARDS

The participating contractors rated the lack of computer standards low. Such a factor was rated low as a hindrance to computerization. The lack of standardization between the many various firms in the computer industry may still not be faced by the construction firms.

4.4.13 OTHER FACTORS

In addition to the listed factors, participating contractors indicated other minor factors hindering construction firms from using computers. Among those is the difficulties that are faced by contractors when changing manual operations to computerized ones. The change might be resisted, specially when the computerized procedures do not match the manned procedures which were applied for a long period of time and the staff were familiar with. Firms, also, mentioned the unavailability of time for learning the new technology. The absence of one general computer system designed for the construction firms' operations was believed to have an influence on the under utilization of computers in the construction industry. The absence of sources of information about software that could be utilized in the construction firms along with the absence of consultants have contributed to the under utilization of computers, according to construction firms.

CHAPTER 5

SUMMARY & RECOMMENDATION

This chapter presents a summary of the study, findings, and the recommendations.

5.1 SUMMARY OF THE STUDY

Computer applications in many industries have received a lot of attention among all professions. The construction industry can utilize computer technology towards more organized, profitable services. In Saudi Arabia, the demand for such implementation of technology will help construction firms to stay in business, be more competitive, and improve services for the clients, especially after the boom period and the lower demand for projects.

This study is an attempt to investigate the use of computer technology by the construction firms in Saudi Arabia. The main objectives of the study are to investigate the utilization of computers in construction firms, the functions in which computers are utilized, and the factors that might hinder construction firms from computer utilization.

In order to achieve these objectives, a survey was the method of getting the information needed. A questionnaire was prepared to seek information that

answered queries achieving the objectives of the study. The questionnaire was sent by mail to 300 randomly selected construction firms working in the Kingdom. The list of construction firms was obtained from the Contractors Classification Agency of the Ministry of Housing and Public Works. A total of 93 contractors responded to the questionnaires. Those that answered questionnaires were analyzed and the necessary information was obtained. Data was coded and entered into the computer. Statistical Analysis System (SAS) was the program used for manipulating data and generating the required calculations and relations resulting from the survey. The results were then organized, and interpreted in tables and chart formats. Findings and conclusions were then found and stated.

5.2 SUMMARY OF THE MAJOR FINDINGS

1. Computer technology is not used widely in construction firms in Saudi Arabia.
2. The percentage of users differs when comparing small, medium and large size categories of firms. As the contractor size increases, the percentage of computer users increases. All large sized contractors, only 62 percent of medium sized contractors, and only 42 percent of small sized contractors use computer systems in their firms.
3. Microcomputers are the most popular systems that are used by contractors.

4. Accounting, word processing, and database are the main functions that computers are utilized for in construction firms.
5. More advanced applications such as expert systems are not utilized by the construction firms.
6. The construction firms showed advancement and better practice with the use of computer technology. Advantages gained by such utilization were shown and appreciated by the users, over practices used before the introduction of the technology. Such advantages included faster operations, more organized handling of problems, more accurate results in minimal time and greater flexibility.
7. Computer sales persons is the main source for selecting computer systems.
8. In house training is the most widely used training programs for all contractors.
9. Lack of computer experience was the main hindrance to using computers in construction firms. This finding was agreed upon by those firms using computers and those who do not.

10. Lack of training programs was a major factor hindering construction firms using computers. Such a conclusion was supported more by those firms having the technology in their operations.
11. The cost of the complete systems and application programs was rated low compared to other factors such as selecting the systems and programs.
12. Generally, management of construction firms feel the importance of computer utilization within construction management.
13. The main hindrances were those associated with the process of implementation of computer systems, not with decision making for computerization.
14. The level of complexity of current non-computerized operations had different importance according to whether the firm is using a computer system or not.
15. Cost considerations have been of less importance to the construction firms than many would expect. The cost of hardware was seen more as an obstacle to computerization.
16. The decision for the utilization of computers and the acceptance of the cost of such a move was justified more by those firms using the

computer systems. Firms that are not using the technology showed a reluctance to justify the costs of transferring the current operations to computerized ones.

17. Incompatibility between different software and hardware, restrictive forms of output, and the absence of computer standards did not contribute much to the under-utilization of computers by construction firms.
18. The two groups of contractors: those who use computers and those who do not, agree on the assessment of factors hindering contractors from computerizing their business operations. This fact remains the same for computer users and non-user in the three contractors size categories: small, medium, and large.

5.3 RECOMMENDATIONS

This section presents general recommendations and recommendations for further studies.

5.3.1. GENERAL RECOMMENDATIONS

1. Universities and computer societies should intensify their efforts in showing contractors, specially small and medium sized contractors, the benefits that can be gained from using computers.

2. Educational institutes should advance courses in various aspects of management that are already computerized.
3. Computer experts have to be involved more in eliminating all factors hindering the use of computers by construction contractors.
4. Computer systems vendors should identify the basic needs of small sized contractors and to come up with systems that cover the main operations with the lowest possible cost.
5. Computer experts should consider publishing Magazines and other computer literature in Arabic.

5.3.2 RECOMMENDATIONS FOR FURTHER STUDIES

1. It is recommended to conduct studies that investigate the utilization of computers in every function within the construction firms, such as accounting, estimating, and scheduling. Bottlenecks and hindrances should be investigated for each function.
2. The development of Arabic language-operated application programs should be investigated as an incentive for construction firms to get more advantages from the technology.

3. Other studies should concentrate on the development of software that includes most of the construction firm's operations, and investigate the feasibility of such products.

APPENDIX A

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Ministry of Higher Education

King Fahd University of Petroleum & Minerals



وزارة التعليم العالي

83

جامعة الملك فهد للبترول والمعادن

October 12, 1991

Dear Manager,

The Construction Engineering & Management of the College of Environmental Design at King Fahd University Of Petroleum & Minerals is presently engaged in a study investigating the use of computers in construction firms in Saudi Arabia.

The purpose of the study is to explore the extent of use of computer technology in construction management.

We are kindly asking you to participate by providing the needed information in the attached questionnaire. We promise that all data of individual firms will be held in strict confidence and will be used for research purpose only. If you are interested in obtaining a copy of the results, please provide us with a P.O. Box so we can send you the results of the study. You can be sure that your identity will not be known since you are not required to write your address.

The Attached questionnaire consists of three sections. The first section seeks information about your firm. The second section seeks information about the use of computer systems by your firm. The last section seeks your evaluation related to factors that affect the use of computers by construction firms.

We shall, therefore, highly appreciate your kindness towards us in rendering the information as per our needs. Your contribution in this regard is highly appreciated.

Enclosed with this letter are two questionnaires; one in Arabic and the other in English. It is to your convenience to complete either form.

Your immediate action will be highly appreciated. Please return the completed questionnaire in the self addressed envelope as soon as possible.

Thank you for your cooperation.

Sincerely yours,

Dr. Ali A. Shash
Study Director

Muhammad H. Al-Amir
Research Associate

QUESTIONNAIRE
=====

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Please answer the following questions by putting a check (✓) mark next to the appropriate answer.

Part I

Questions About Your Firm

1. Type of entity :

<input type="checkbox"/> Family owned	<input type="checkbox"/> Partnership
<input type="checkbox"/> Corporation	<input type="checkbox"/> Joint-Venture: <u> </u> Saudi-Saudi
<input type="checkbox"/> Other: <u> </u>	<u> </u> Saudi-Forigen

2. Type of contractor & class :

	% of work	Grade
<input type="checkbox"/> Building	<u> </u>	<u> </u>
<input type="checkbox"/> Engineering	<u> </u>	<u> </u>
<input type="checkbox"/> Industrial	<u> </u>	<u> </u>
<input type="checkbox"/> Other (Please specify) <u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
Total	<u> </u> 100 %	

3. Average annual business volume :
(Millions of Saudi Riyals)

4. Number of years in business :

5. Average contract size that your firm obtain (Millions of SR) :

<input type="checkbox"/> Under 5	<input type="checkbox"/> 5 - Under 20
<input type="checkbox"/> 20 - Under 35	<input type="checkbox"/> 35 - Under 50
<input type="checkbox"/> 50 - 100	<input type="checkbox"/> Over 100

6. Number of full time employees :

<input type="checkbox"/> Administrative	<u> </u>	Saudis <u> </u> %
<input type="checkbox"/> Technical & Engineers	<u> </u>	Saudis <u> </u> %
<input type="checkbox"/> Blue collar and field labor	<u> </u>	Saudis <u> </u> %

7. Value of construction equipments owned (Millions of SR):

<input type="checkbox"/> Under 5	<input type="checkbox"/> 5 - Under 15
<input type="checkbox"/> 15 - Under 25	<input type="checkbox"/> 25 - Under 35
<input type="checkbox"/> 35 - 45	<input type="checkbox"/> Over 45

8. Percentage of equipment rented or leased :

<input type="checkbox"/> None	<input type="checkbox"/> Under 25%
<input type="checkbox"/> 25% - Under 50%	<input type="checkbox"/> 50% - Under 75%
<input type="checkbox"/> 75% - 100%	

9. Region of operation in Saudi Arabia :

<input type="checkbox"/> East	<input type="checkbox"/> West
<input type="checkbox"/> South	<input type="checkbox"/> North
<input type="checkbox"/> Center	<input type="checkbox"/> International
<input type="checkbox"/> Other (Please specify) <u> </u>	

10. Number of Area/Branch offices :
(Excluding main office & site offices):

Part II

Questions About The Current Use Of Computers

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11. Are you using a computer in your company ?
☐ Yes
☐ No (Please Go to Ques. 25)
12. What type(s) of computer system does your firm use ?
- | Type | Model | Quantity |
|---------------------------------------------|-------|----------|
| <input type="checkbox"/> Mainframe computer | _____ | _____ |
| <input type="checkbox"/> Minicomputer | _____ | _____ |
| <input type="checkbox"/> Microcomputer | _____ | _____ |
13. For how long has your firm been using the computer ?
 _____ Years
14. For what function(s) did your firm originally purchase the computer system ?
- | | | |
|--------------------------------------------------|-------------------------------------|------------------------------------------|
| <input type="checkbox"/> Accounting | <input type="checkbox"/> Scheduling | <input type="checkbox"/> Word Processing |
| <input type="checkbox"/> Database | <input type="checkbox"/> Estimating | <input type="checkbox"/> Spreadsheet |
| <input type="checkbox"/> Other Function(s) _____ | | |
| _____ | | |
| _____ | | |
15. How did your firm go about choosing the computer system ?
- | | | |
|----------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Magazines | <input type="checkbox"/> Brochures | <input type="checkbox"/> Personal contact |
| <input type="checkbox"/> Articles | <input type="checkbox"/> Books | <input type="checkbox"/> Sales Person |
| <input type="checkbox"/> Seminars | <input type="checkbox"/> Consultant | |
| <input type="checkbox"/> Other : _____ | | |
| _____ | | |
| _____ | | |
16. How did your firm go about choosing application programs ?
- | | | |
|----------------------------------------|-------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Magazines | <input type="checkbox"/> Brochures | <input type="checkbox"/> Personal contact |
| <input type="checkbox"/> Articles | <input type="checkbox"/> Books | <input type="checkbox"/> Sales Person |
| <input type="checkbox"/> Seminars | <input type="checkbox"/> Consultant | |
| <input type="checkbox"/> Other : _____ | | |
| _____ | | |
| _____ | | |
17. How were your users trained to use the system ?
- | |
|-----------------------------------------------------------------------------|
| <input type="checkbox"/> Short course sponsored by the Sales representative |
| <input type="checkbox"/> Tutorial |
| <input type="checkbox"/> Manuals |
| <input type="checkbox"/> Experienced in-house users |
| <input type="checkbox"/> Other : _____ |
| _____ |
| _____ |
18. The following functions have to do with possible uses of the computer in construction company management. Please check (✓) those functions which you are currently performing on the computer, and indicate by an X those functions which you would like to be able to perform. In addition, specify -if possible- software program(s) utilized for each function. If you are using program(s) developed in your firm, please mention it :

Functions	Programs utilized
<input type="checkbox"/> Accounting	
<input type="checkbox"/> Payroll	
<input type="checkbox"/> General Ledger	
<input type="checkbox"/> Accounts Receivable	
<input type="checkbox"/> Accounts Payable	
<input type="checkbox"/> Balance Sheet	
<input type="checkbox"/> Income Statement	
<input type="checkbox"/> Spreadsheet Calculation	
<input type="checkbox"/> Estimating	
<input type="checkbox"/> Job Costing	
<input type="checkbox"/> Cash Flow	
<input type="checkbox"/> Equipment Replacement Analysis	
<input type="checkbox"/> Graphics	
<input type="checkbox"/> Scheduling	
<input type="checkbox"/> Resource Leveling	
<input type="checkbox"/> Cash Flow Requirements	
<input type="checkbox"/> Estimating (Vendor Written)	
<input type="checkbox"/> Word Processing	
<input type="checkbox"/> Contract Language Retrieval	
<input type="checkbox"/> Process Daily Logs	
<input type="checkbox"/> Data Base	
<input type="checkbox"/> Staff Information	
<input type="checkbox"/> Equipment Information	
<input type="checkbox"/> Project Information	
<input type="checkbox"/> Warehouse Information	
<input type="checkbox"/> Linking with Field Office	
<input type="checkbox"/> Computer-Aided Design & Drafting	
<input type="checkbox"/> Risk Analysis	
<input type="checkbox"/> Bidding Strategies	
<input type="checkbox"/> Expert Systems	
<input type="checkbox"/> Other (Please specify)	

19. If your firm is using a computer for accounting, what are the advantages gained by using the computer over the practice before using it?

20. If your firm is using a computer for database, what are the advantages gained by using the computer over the practice before using it?

21. If your firm is using a computer for scheduling, what are the advantages gained by using the computer over the practice before using it?

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22. If your firm is using a computer for estimating, what are the advantages gained by using the computer over the practice before using it?

23. If your firm is using a computer for word processing, what are the advantages gained by using the computer over the practice before using it?

24. If your firm is using a computer for spreadsheet, what are the advantages gained by using the computer over the practice before using it?

Part III

Questions About Factors Affecting The Underutilization

25. The following are possible factors hindering construction firms from using computers. Please rate the level of effect of each on the underutilization of computers by circling the appropriate number :

1= No Effect

5= Very Major Effect

Computer is not needed	5	4	3	2	1
Cost of hardware	5	4	3	2	1
Cost of software	5	4	3	2	1
Cost effectiveness(Return on investment)	5	4	3	2	1
Lack of computer experience	5	4	3	2	1
Unsophisticated management methods	5	4	3	2	1
Difficulty in selecting the right system	5	4	3	2	1
Difficulty in selecting software programs	5	4	3	2	1
Restrictive forms of output	5	4	3	2	1
Lack of training programs	5	4	3	2	1
Lack of computer standards	5	4	3	2	1
Hardware and software incompatibility	5	4	3	2	1
Others (Please specify)	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1
	5	4	3	2	1

26. If you have any additional comment, please feel free to add them below ;

THANK YOU FOR YOUR COOPERATION



التاريخ ٥ / ٤ / ١٤١٢ هـ

المقرر

السيد المدير

تخية طيبة وبعد

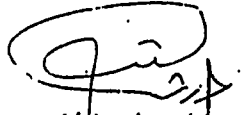
يقدم قسم الهندسة وإدارة التشييد في كلية تصاميم البيئة بجامعة الملك فهد للبترول والمعادن بعمل دراسة عن استخدام الحاسب الآلي في مؤسسات التشييد في المملكة العربية السعودية .

الغرض من الدراسة هو معرفة مدى استخدام تقنية الحاسب الآلي في مجال إدارة التشييد .

مساهمتك في هذه الدراسة تكون بتزويدنا بالمعلومات الضرورية من خلال الاستبيان المرفق . كل المعلومات ستعامل بسرية تامة ونعدكم بأنها لن تستخدم الا لغرض البحث فقط . إذا كنت ترغب في الحصول على نتائج هذه الدراسة فما عليك الا أن تزودنا بعنوانك لإرسالها إليك .

الاستبيان المرفق يتكون من ثلاث أقسام . القسم الأول فيه أسئلة عن مؤسستكم والقسم الثاني فيه أسئلة عن استخدام الحاسب الآلي في مؤسستكم . أما القسم الثالث فهو عبارة عن تقييمكم للعوامل السلبية المؤثرة على الاستخدام المتدني للحاسب الآلي في مؤسسات التشييد .

تكرمكم بتزويدنا بالمعلومات اللازمة لإتمام الدراسة سيكون موضع تقديرنا وإحترامنا ومرفق مع هذه الرسالة إستبيانين أحدهما باللغة العربية والآخر باللغة الانجليزية ، وبإمكانكم الاجابة على أي منهما كما ترونه مناسباً . تجاوبكم السريع سوف يساهم في إتمام الدراسة والإنتفاع بنتائجها في المستقبل القريب . فالرجاء موافاتنا بالاستبيان المكمل في أسرع وقت ممكن في الظرف المعنون المرفق .
وتقبلوا فائق الإحترام .


د . علي علي شايخ

استاذ مساعد ، مشرف على الدراسة


محمد حسن الأمير

مشارك في للبحث

استبيان

الرجاء الإجابة على الأسئلة التالية :-

أولاً :-

أسئلة بخصوص المؤسسة

١ - نوع المؤسسة

- [] ملكية عائلية [] شركة
 [] شركة مساهمة [] شركة إندماجية :- سعودية - سعودية
 [] أخرى :- سعودية - أجنبية

الدرجة

٢ - نوع الممارول ودرجة تمثيلية

- [] مبانئي (سكنية تجارية تعليمية ، الخ)
 [] هندسي (طرق ، سدود ، إنشاءات ثقيلة ، الخ)
 [] صناعي (محطات كهرباء ، مصافي ، الخ)
 [] غير ذلك (الرجاء التحديد)

٪١٠٠

٣ - ماحر متوسط حجم أعمالكم السنوية :

(ملايين الريالات السعودية)

٤ - عدد سنوات العمل في مجال صناعة التشييد :-

٥ - متوسط قيمة العقود التي تقومون بتنفيذها (ملايين الريالات السعودية) :-

- [] أقل من ٥ [] ٥ - أقل من ٢٠
 [] ٢٠ - أقل من ٢٥ [] ٢٥ - أقل من ٥٠
 [] ٥٠ - ١٠٠ [] أكثر من ١٠٠

٦ - عدد الموظفين الدائمين :-

- [] الإداريين
 [] المهندسين والفنيين
 [] العمال
 نسبة السعوديين ٪
 نسبة السعوديين ٪
 نسبة السعوديين ٪

٧ - قيمة معدات التشييد المملوكة (ملايين الريالات السعودية) :-

- [] أقل من ٥ [] ٥ - أقل من ١٥
 [] ١٥ - أقل من ٢٥ [] ٢٥ - أقل من ٤٥
 [] ٤٥ - ١٠٠ [] أكثر من ١٠٠

٨ - نسبة معدات التشييد المستأجرة :-

- [] لا شيء [] ٢٥ ٪ - أقل من ٢٥ ٪
 [] ٢٦ ٪ - ٥٠ ٪ [] ٥١ ٪ - ٧٥ ٪
 [] ٧٦ ٪ - ١٠٠ ٪

٩ - منطقة العمل في المملكة العربية السعودية :-

- [] الشرق [] الغرب
 [] الجنوب [] الشمال
 [] الوسطى [] عالميا
 [] أماكن أخرى (الرجاء التحديد)

١٠ - عدد المكاتب الفرعية :-

(بإستثناء المكتب الرئيسي ومكاتب الموقع)

ثانيا
معلومات عن استخدام الحاسب الآلي

١١ - هل تستخدمون حاليا نظام الحاسب الآلي في مؤسستكم ؟

[] نعم

[] لا (الرجاء التوجه للسؤال رقم ٢٥)

١٢ - ماهو نوع نظام (انظمة) الحاسب الآلي المستخدم

العدد	النوع	إسم ورقم الجهاز
_____	[] حاسب آلي رئيسي	_____
_____	[] حاسب آلي متوسط	_____
_____	[] حاسب آلي شخصي	_____

١٣ - ماهي الفترة التي مضت على استخدام الحاسب الآلي :

سنة _____

١٤ - لأي غرض (أغراض) إشتريتم أساسا نظام الحاسب الآلي :

[] الحاسبة [] الجدولة والتنظيم [] معالجة النصوص
[] قواعد البيانات [] تقدير التكاليف [] القوائم الحسابية
[] مصادر أخرى : _____

١٥ - علام اعتمدتم في اختياركم لنظام الحاسب الآلي :

[] الدوريات (المجلات) [] كتيبات الدعاية [] المعرفة الشخصية
[] المقالات [] الكتب [] مندوبي المبيعات
[] الدوريات لتعليمية (المحاضرات) [] الاستشاريون
[] مصادر أخرى : _____

١٦ - علام اعتمدتم في اختياركم لبرامج تطبيقات الحاسب الآلي :

[] الدوريات (المجلات) [] كتيبات الدعاية [] المعرفة الشخصية
[] المقالات [] الكتب [] مندوبي المبيعات
[] الدوريات لتعليمية (المحاضرات) [] الاستشاريون
[] مصادر أخرى : _____

١٧ - كيف تم تدريب موظفيكم على استخدام الحاسب الآلي :

[] دورات تدريبية قصيرة من قبل مندوبي المبيعات
[] المرشد الشخصي المبرمج داخل البرامج
[] كتيبات دليل الاستخدام
[] من قبل موظفين لديكم من ذوي الخبرة
[] أخرى : _____

١٨ - تتضمن القائمة التالية الاستخدامات المختلفة لأنظمة الحاسب الآلي في إدارة مؤسسة التشييد . نرجوا التكرم بوضع علامة (X) أمام الوظائف التي تستخدمون الحاسب الآلي فيها حاليا . وعلامة X أمام تلك الوظائف التي ترغبون في استخدام الحاسب الآلي فيها مستقبلا . يرجى كذلك ذكر البرامج المستخدمة لكل وظيفة وفي حال استخدام برامج مطورة من قبل مؤسستكم ، يرجى ذكرها كذلك .

الوظيفة	البرامج المستخدمة
[] الحاسبة	
[] الرواتب	
[] الأستاذ العام	
[] حسابات مدينة	
[] حسابات دائنة	
[] الميزانيات	
[] قائمة الإيرادات	
[] القوائم الحسابية	
[] تقدير التكلفة	
[] تكلفة المبيعات	
[] السيولة النقدية	
[] تحليل إحلل المعدات	
[] الرسومات البيانية	
[] الجدولة والتنظيم	
[] تنظيم وموازنة المصادر	
[] متطلبات السيولة النقدية	
[] تقدير التكاليف (برامج خاصة لحساب التكاليف)	
[] معالجة النصوص	
[] إسترجاع معلومات العقود	
[] التقارير اليومية (المراسلات ، التقارير ، ... الخ)	
[] قواعد البيانات	
[] حفظ معلومات الموظفين	
[] حفظ معلومات الأجهزة والمعدات	
[] حفظ معلومات المشاريع	
[] حفظ معلومات المستودعات	
[] الاتصال بمكتب الموثق	
[] التسميم والرسم بالحاسب الآلي	
[] تحليل الفسائر	
[] استراتيجيات العطاءات	
[] نظم الخبرة	
[] أغراض أخرى (الرجاء التحديد)	

١٩ - إذا كنتم تستخدمون الحاسب الآلي في المحاسبة فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

٢٠ - إذا كنتم تستخدمون الحاسب الآلي في قواعد البيانات فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

٢١ - إذا كنتم تستخدمون الحاسب الآلي في الجدولة والتنظيم فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

٢٢ - إذا كنتم تستخدمون الحاسب الآلي في تقدير التكاليف فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

٢٣ - إذا كنتم تستخدمون الحاسب الآلي في معالجة النصوص فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

٢٤ - إذا كنتم تستخدمون الحاسب الآلي في الأغراض الحسابية باستخدام القوائم الآلية فما هي المميزات التي أضافها استخدام الحاسب الآلي غير تلك التي كانت متوفرة قبل استخدامه ؟

ثالثاً

أسئلة يخصصون العوامل المؤثرة على الاستخدام المتدني للحاسب الآلي .

٢٥ - تتضمن القائمة التالية العوامل المحتملة التي تؤثر سلباً على مؤسسات التشييد فيما يتعلق باستخدام الحاسب الآلي . انرجاء وضع دائرة حول الرقم الذي ترونه يمثل رأيكم في التأثير السلبي للعامل المذكور على استخدام الحاسب الآلي .

٥ = تأثير مهم جداً

١ = لا تأثير

١	٢	٣	٤	٥	التاسبات الآلية غير ضرورية
١	٢	٣	٤	٥	تكاليف أجهزة الحاسب الآلي
١	٢	٣	٤	٥	تكاليف البرامج المستخدمة
١	٢	٣	٤	٥	السائد المتوسع على الاستثمار
١	٢	٣	٤	٥	قلة الخبرة في مجال الحاسب الآلي
١	٢	٣	٤	٥	عدم وجود طرق إدارية مفصلة
١	٢	٣	٤	٥	مدونية الاختيار الصحيح لتنظيم الحاسب الآلي
١	٢	٣	٤	٥	النماذج غير المرونة للبرامج
١	٢	٣	٤	٥	عدم وجود برامج تدريب على الحاسب الآلي
١	٢	٣	٤	٥	عدم وجود معايير للحاسب الآلي
١	٢	٣	٤	٥	عدم توافق أجهزة وبرامج الحاسب الآلي
					عوامل أخرى (الرجاء ذكرها)
١	٢	٣	٤	٥	
١	٢	٣	٤	٥	
١	٢	٣	٤	٥	

٢٦ - إذا كانت لديكم أي ملاحظات أو تعليقات أو مقترحات أخرى الرجاء ذكرها فيما يلي :

شاكرون لكم حسن تعاونكم .



التاريخ : ١٤١٦/٥/١٧ هـ

الموقر

السيد المدير

تحية طيبة وبعد

لقد سبق أن أرسلنا لسعاتكم استبانة بخصوص استخدامات الحاسب الآلي في مؤسسات التشييد ونود اشعاركم انه لم يصلنا منكم الرد حتى تاريخه .

ونود ان نلفت عنايتكم الى ان الاستبانة جزء من دراسة يعتمد اتمامها و نجاحها على مشاركتكم الفعالة بامدادنا بالمعلومات المطلوبة . ولا يخفى على سعاتكم أن نتائج هذه الدراسة سوف تعود على صناعة التشييد في المملكة بالنفع الكبير . ولذا نرجو من سعاتكم التعاون معنا وارسال الاستبيان مكملًا في أسرع وقت ممكن ولكم الشكر الجزيل .

ونؤكد لكم مرة اخرى ان المعلومات لن تستخدم الا لغرض البحث فقط , وانها لن تعرض بصورة فردية ولن يعرف مصدر المعلومات مطلقًا .

ملاحظه : اذا كنتم قد ارسلتم الاستبانة فلكم الشكر الجزيل ونعدكم ان جهودكم لن يضيع سدى .

د. علي ع. شاش
استاذ مساعد/مشرّف على الدراسة

APPENDIX B

11. Other functions

What management functions of your construction company would you like to computerize?

Are your software programs easy to use (user friendly)?

Were they easy to learn?

What "bottle-necks" are keeping you from performing the tasks you would like to perform?

Answer the following questions if you are currently not using a personal computer.

Why are you not using a personal computer?

1. Current management operations not sufficiently complex
2. Cost of computer and software
3. Lack of experience in using computers
4. Other reasons

SURVEY OF CONTRACTOR'S UTILIZATION OF COMPUTERS

CONTRACTOR:

CONTRACT/TITLE:

DATE:

What is your annual dollar volume of construction?

\$ _____

How many persons do you employ in any given year?

How long has your firm been using the computer?

_____ years

For what functions did you originally purchase the computer?

_____ Accounting	_____ Scheduling	_____ Word Processing
_____ Database	_____ Estimating	_____ Spreadsheet

OTHER FUNCTION(s) _____

What hardware does your company possess?

Make _____

_____ Disk Drives: How many? _____, What size disks? _____
_____ Hard Drive: How many megabytes of memory? _____
_____ Monitor: Color or Monochrome?
_____ Printer: Dot Matrix or Laser?
_____ Tape Back-up
_____ Modem

Approximate Total Cost of System: \$ _____

What software does your company possess?

	NAME OF PROGRAM	VENDOR	APPROX. PRICE
___ Accounting Package:			
___ Payroll			
___ General Ledger			
___ Accounts Receivable			
___ Accounts Payable			
___ Job Costing			
___ Word Processor:			
___ Spreadsheet:			
___ Data Base:			
___ Scheduling Program:			
___ Estimating Program:			

Approximate Total Cost if Not Itemized: \$ _____

The following factors have to do with possible uses of the microcomputer in construction company management. Please check () those functions which you are currently performing on the computer, and indicate by an X those functions which you would like to be able to perform. Then, regardless of your use, rate your perceived value of the following functions by circling the appropriate number.

	HIGH		ERATE	LITTLE	NONE
_____ ACCOUNTING	4	3	2	1	0
_____ PAYROLL	4	3	2	1	0
_____ GENERAL LEDGER	4	3	2	1	0
_____ ACCOUNTS RECEIVABLE	4	3	2	1	0
_____ JOB COST	4	3	2	1	0
_____ BALANCE SHEETS	4	3	2	1	0
_____ INCOME STATEMENT	4	3	2	1	0
_____ SPREADSHEET CALCULATIONS	4	3	2	1	0
_____ ESTIMATING	4	3	2	1	0
_____ JOB COSTING	4	3	2	1	0
_____ CASH FLOW	4	3	2	1	0
_____ EQUIPMENT REPLACEMENT	4	3	2	1	0
_____ GRAPHICS	4	3	2	1	0
_____ SCHEDULING	4	3	2	1	0
_____ RESOURCE LEVELING	4	3	2	1	0
_____ CASH FLOW REQUIREMENTS	4	3	2	1	0
_____ ESTIMATING (VENDOR WRITTEN)	4	3	2	1	0
_____ WORD PROCESSING	4	3	2	1	0
_____ CONTRACT LANGUAGE RETRIEVAL	4	3	2	1	0
_____ PROCESS DAILY LOGS	4	3	2	1	0
_____ DATA BASE	4	3	2	1	0

___ COMMUNICATION WITH FIELD OFF.	4	3	2	1	0
___ COMPUTER-AIDED DRAFTING	4	3	2	1	0
___ COMPUTER-AIDED DESIGN	4	3	2	1	0
___ PROCESS SIMULATION	4	3	2	1	0
___ RISK ANALYSIS	4	3	2	1	0
___ EXPERT SYSTEMS	4	3	2	1	0
___ ROBOTICS	4	3	2	1	0
___ OTHER	4	3	2	1	0
___ OTHER	4	3	2	1	0

METHOD OF INFORMATION INPUT

___ KEY BOARD	4	3	2	1	0
___ LIGHT PIN	4	3	2	1	0
___ ROLLING BALL (MOUSE)	4	3	2	1	0
___ TOUCH SENSITIVE PAD	4	3	2	1	0
___ VOICE RECOGNITION	4	3	2	1	0
___ OTHER	4	3	2	1	0

This next section focuses on some areas that have been "BOTTLENECKS" in the past. Its purpose is to see if these are still problems hindering contractor's use of computers. Please indicate whether "YES" it is/was a hindrance, or "NO" it is/was not a hindrance to your using microcomputers.

WAS THERE DIFFICULTY IN SELECTING THE RIGHT SYSTEM? ___ YES ___ NO

How did you go about choosing your hardware?

___ Magazines	___ Brochures	___ Personal Contact
___ Articles	___ Books	___ Sales Person
___ Mail Order	___ Seminar	___ Consultant
___ Other		

How did you go about choosing your software?

___ Magazines	___ Brochures	___ Personal Contact
___ Articles	___ Books	___ Sales Person
___ Mail Order	___ Seminar	___ Consultant
___ Other		

What were the difficulties in choosing the best system for your firm?

- ☐ Overwhelming quantity of computer information
- ☐ Inconsistency in information
- ☐ Lack of computer experience
- ☐ Absence of a credible reference

OTHER _____

IS INCOMPATIBILITY A PROBLEM?

☐ YES ☐ NO

Are there any hindrances to your ability to pass information directly from one software program to another? ☐ YES ☐ NO

Do or did you have any problems interfacing the software with the hardware? ☐ YES ☐ NO

Did you purchase your software and hardware at the same time? ☐ YES ☐ NO

Do you have problems in getting the printer to print your desired information? ☐ YES ☐ NO

DOES YOUR SCHEDULING PROGRAM MEET YOUR EXPECTATIONS?

☐ YES ☐ NO

If your company does not use a computer program for scheduling, could you please list a few reasons why not?

If you are using a scheduling computer package, are you having problems in any of these or other areas?

- ☐ Flexibility of labeling
- ☐ Updating the schedule with current start/finish dates
- ☐ Integrating portions of sub-schedules
- ☐ Integrating information from a Data Base
- ☐ Plotting
- ☐ Cash flow forecasts
- ☐ Resource leveling
- ☐ Sufficient memory in hardware system

OTHER _____

DOES YOUR ESTIMATING PROGRAM MEET YOUR EXPECTATIONS? ☐ YES ☐ NO

If your company does not use a computer program for estimating, could you please list a few reasons why not?

If you are using a computer for estimating, are you using a spreadsheet or a vendor written program?

☐ spreadsheet ☐ vendor written

Are you having difficulty with your estimating system for any of the following reasons?

- ☐ Inflexible formats
- ☐ Inflexible methods of calculating costs
- ☐ Difficulty in running "what-if?" scenarios
- ☐ Inflexible cost codes
- ☐ Restrictive formats

OTHER _____

ARE THE FORMS OF OUTPUT RESTRICTIVE? ☐ YES ☐ NO

IS IT DIFFICULT FOR YOUR COMPANY TO JUSTIFY THE COST OF YOUR COMPUTER SYSTEM?
☐ YES ☐ NO

Do you or have you had difficulty in justifying the cost of your hardware?
☐ YES ☐ NO ☐ SOME PARTS

Do you or have you had difficulty in justifying the cost of your software?
☐ YES ☐ NO ☐ SOME PROGRAMS

HAS TRAINING YOUR USERS IN COMPUTER USE BEEN DIFFICULT? ☐ YES ☐ NO

How were your users trained?

- ☐ Short Courses sponsored by the
Sales representative _____
- ☐ Software vendor _____
- ☐ Tutorial
- ☐ Manuals
- ☐ Experienced in-house users

Were there any complaints about the method in which your users were trained?

Finally, any suggested solutions that you might have for improving the computer's use and availability would be appreciated at this time.

SELECTING THE RIGHT SYSTEM:

What source of information was or would be of most value to you in future computer hardware or software selection?

SCHEDULING:

What functions would you like your scheduling package to perform?

ESTIMATING:

What functions would you like your estimating system to perform?

OTHER SUGGESTIONS:

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VITA

MUHAMMAD HASAN AL-AMIR Finished his high school in 1984 from Mo'ath Bin Jabal High School in Gizan, Saudi Arabia. He joined King Fahd University of Petroleum and Minerals (KFUPM) at Dhahran, Saudi Arabia, in the same year. He graduated from KFUPM with a BACHELOR OF ARCHITECTURE with HONORS in June 1989. In the same year, he enrolled at KFUPM as a graduate student in the Construction Engineering and Management Program. He graduated from KFUPM with a MASTER DEGREE in CONSTRUCTION ENGINEERING AND MANAGEMENT in January 1994.